# Municipal and County Engineering

**DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS**

Vol. LXVI. FEBRUARY, 1924 No. 2

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# Contracts Awarded

## ROADS AND STREETS

**Ala., Montgomery**—J. Gwin, Hamilton Sta., Birmingham, awarded contract by State Hwy. Dept. for grading and cherting 3.82 miles Birmingham-Decatur Rd., 20 ft., Jefferson and Blount Cos., at $110.477; W. C. McCoy, LaFayette, awarded contract for grading and graveling 16 miles Dixie Overland Hwy., Dallas and Perry Cos., at $110.781.

**Ark., Blytheville**—E. E. Park of H. H. Hall Constr. Co., E. St. Louis, Ill., awarded contract to build last connecting link in Blytheville-Osceola-Memphis hard rd., 20 ft. wide; 6-in. conc. base and 2-in. Warrenite top, at $734,000.

**Ariz., Tucson**—Borderland Construction Co., Tucson, awarded contract to improve Speedway and Campbell Ave.; 87,150 sq. yds. subgrade, 55,920 sq. yds. paving, etc., at $158,750.

**Cal., Glendale**—Thompson & Heuser, Loew State Bldg., Los Angeles, awarded contract by city for grade, 16,750 sq. ft. B curb, 32,480 sq. ft. conc. improving Sycamore Canyon Rd.; 758,000 sq. ft. gutter, 476,000 sq. ft., asphalt concrete base with 1½-in. National surface, etc., at $194,125.

**Cal., Los Angeles**—Will F. Peck, 602 Hollywood Security Bldg., awarded contract by Board Pub. Wks. for impvt. of Vine St., at $316,937. Work involves asph. and conc. paving and grading; bitum. base, walk, san. sewers, curbs, etc., etc.; Wm. Liddington, 420 E. 60th St., awarded contract by Bd. Public Works for impvt. of Alvarado St., Glendale Blvd. to Ocean View Ave., at $154,783.

**Cal., Sacramento**—Galbraith & Jones, San Mateo, awarded contract for constr. of state hwy. in Sonoma Co., bet. Beltane and Schelville; about 11.5 miles in length, to be graded and 7.2 miles surfacing with gravel or broken stone and 4.3 miles to be paved with cement conc., at $274,760; Kaiser Paving Co., Oakland, awarded contract for constr. of state hwy. in Sacramento Co., bet. Old Elk Grove and Sacramento, about 9 miles to be paved with cement concrete, at $283,666.

**Cal., Sacramento**—Nevada Contracting Co., Fallon, Nev., awarded contract by State Hwy. Commission for grading and widening Pacific Hwy., Shasta Co., at $480,862; Irey & Holden, Lodi, awarded contract for grading section of Victory Hwy., bet. Truckee and Boca, 7 miles, at $67,852.

**Cal., Sacramento**—Jahn & Brossi, 618 Laughlin Bldg., Los Angeles, awarded contract for constr. of state hwy. bet. Del Mar and Oceanside, San Diego Co., at $436,645; abt. 16.2 mi. in length, to be paved with cement concrete.

**Cal., San Diego**—Griffith Co., 25 14th St., awarded contract by City Council for paving 1st, 2nd and 3rd Sts., at $55,540; G. R. Daley, 4430 Boundary St., awarded contract for paving Maryland St., Madison to VanBuren, at $20,943, also paving Girard St. and Coast Blvd., at $35,467, and improving Louisiana St., Upas to Lincoln Sts., at $26,281; Griffth Co., 25 14th St., San Diego, contract for impvt. of 24th, 25th and B Sts., at $42,149; also contract for improving Redwood, Spruce, 3rd and Front Sts., at $21,628.

**Cal., Whittier**—Griffith Co., 502 L. A. Ry. Bldg., awarded contract at approx. $82,000 for impvt. of Bailey St., east to west city limits.

**Conn., Hartford**—State Hwy. Comn. let following contracts for road impvts.: J. Arboria, 82 Church St., New Haven, 25,441 ft. Cornwall-Kent Hwy., at $182,659, 9,560 ft. bitum. macadam in Mansfield, at $50,073; 12,325 ft. waterbound macadam, Southbury Rd., $56,857; 8,354 ft. rein. conc., in Shelton, $44,422; 7,430 ft. trap rock waterbound macadam on Abington Rd., in Pomfret, at $34,663; J. Demichiel & Bro., 48 High St., Torrington, 20,867 ft. waterbound macadam in Sharon, at $187,132; D. O'Connell & Sons, Holyoke, Mass., 13,400 ft. rein. conc. in Suffield, $84,118; to F. Arrigoni & Son, 624 Main St., Middletown, 21,000 ft. waterbound macadam on Groton-Stonington Rd., $105,319; Berlin Constr. Co., Berlin, Southbury bridge over Pomperaug river, at $11,884.

**Fla., Clearwater**—Pinellas County let the following contracts: Davis Miller, Cone Bros. and Peninsula Constr. Co., care W. H. Armston, Tampa, 13.2 mi. rd. 1 A, St. Petersburg to Clearwater; 69,024 sq. yds. asph. blk., 122,000 lin. ft. conc. curbing, 72,000 cu. yds. earth excav., 60,000 sq. yds. old brick relaid, $348,670; 13.2 mi. Rd. 1 B, Clearwater to Pasco Co. line, 74,000 sq. yds. asph. blk., 139,000 lin. ft. conc. curbing, 80,000 cu. yds. excav., 50,000 sq. yds. relaid brick, $368,045; 11.45 mi. Rd. 2, Clearwater to Hillsborough Co. line, 77,30* sq. yds. asph. blk., 121,154 lin. ft. conc. curbing, 64,000 c. y. excav., $333,162; 7 miles Rd. 3, Ozon to 1 mile n. w. Oldsmar, 35,933 sq. yds. asph. blk., 73,950 lin. ft. conc. curbing, 40,000 c. y. excav., 30,200 sq. yds. relaid brick, $181,142; 14.7 mi. Rd. 4, Indian Rock drawbridge to Dellwood, 103,000 sq. yds. asph. blk., 154,000 lin. ft. conc. curbing, 94,000 c. yds. excav., 25,701 sq. yds. brick relaid, $413,473; 10.04 mi. Rd. 5, 10.900 sq. yds. vit, brk., 5,280 lin. ft. conc. curbing and guttering, 50,000 c. y. excav., 43,606 sq. yds. brick relaid, etc., $154,923; 6.92 mi. Rd. 6, 69,600 sq. yds. asph. brick, 78,292 lin. ft. conc. curbing, 55,000 c. y. excav., etc., $255,786; 6.05 mi. Rd. 7, 106,550 sq. yds. asph. blk., 64,000 lin. ft. concrete curbing, 30,750 c. y. excav., 105,550 sq. yds. asph. blk, 1,600 lin. ft. conc. curbing, etc., $5,614.

**Fla., Dade City**—G. F. S. Whitney, St. Augustine, Fla., awarded contract by State Rd. Dept., to grade, construct drainage structs. and lay rock base on 8.75 mi. Rd. No. 5, Pasco Co., at $118,254.

**Fla., Lakeland**—City let contracts at $900,000 to Jas. G. Yeats, Tampa, Fla., and Stidman & Hughes, Bartow, Fla., for 230,000 sq. yds. brick paving and 15,000 sq. yds. asphalt widening; Newell Contracting Co. received contract for concrete curb.

**Tampa, Fla.**—Cone Bros., Tampa, awarded contract for paving streets in Tampa (Palma Ceia) section; asph. block, at approx. $175,000.

**Fla., Vero**—H. L. Clark & Sons, Vero, awarded contract for grading and paving 8 miles asphalt treated macadam, at $228,000.

**Ga., East Point**—Sam Finley Co., 212 W. North Ave., Atlanta, Ga., awarded contract for surfacing, sheet asph., 2 mi. Albany-Americus Rd., F. A. P. 208, Daugherty Co., at $35,224; with macadam, 2.66 miles Blue Ridge—Cooperhill Rd., F. A. P. 358, Fannin Co., to Nicholas Constr. Co., 1 La France, Atlanta, at $64,572.

**Idaho, Boise**—J. A. Terteling & Sons, Moscow, awarded contract by Bureau of Hwys., for grading and crushed rock surfacing 10.25 mi. F. A. P. 75, Secs. A and B, at total cost of $100,844.

**Ind., Indianapolis**—Lowell F. Parker & Co., Bloomfield, awarded contract by Marion Co. for grading and paving with Portland cement 2.97 miles Russell N. Edwards Rd. and Penn. St., at $106,700.

**Ind., Indianapolis**—State Hwy. Comn. let contract for paving Federal Aid Rd. 67, Sec. A, Lagrange Co., 81,017 sq. yds. conc., to R. Daoust, Defiance, Ohio, at $181,281; widening and grading 8.176 mi. F. A. Rd. 68, Sec. G, Parke Co., 149,267 c. y. excav., to Ellis & Scamahorn, Rockport, at $93,178; conc. paving, 5.743 miles, F. A. Rd. 74, Sec. B, Boone Co., 76,755 sq. yds. conc., and 8.639 mi. Sec. C, Clinton and Tippecanoe Cos., 83,039 sq. yds. conc., to J. M. Snyder, Frankfort, at $112,955 and $158,333, respectively.

**Ill., Duquoin**—Southern Illinois Quarry and Construction Co., Murphysboro, awarded contract for grading and rein. conc. surfacing, approx. 9,000 ft. So. Washington St., etc., at $97,231.

**Ill., Galesburg**—H. H. Gunther, 859 E. Loesy St., awarded contr. for improving Grand Ave., 7,620 c. y. grading, 10,198 lin. ft. conc. curb and gutter, 18,004 sq. yds. brick pavement on 4-in. conc. base with asphalt filler, etc., at $65,843.

**Ia., Manchester**—Bryant Paving Co., 807 Black Hawk Bank Bldg., Waterloo, awarded contract for paving 48 blks. with asph. conc., at $2.51 per sq. yd.; 52,132 sq. yds. pavement, 500 c. y. excess excav., 700 comb. curb and gutter.

**Ia., Shenandoah**—J. F. McLaughlin & Sons, Red Oak, awarded contract for paving at $159,465; 51,000 sq. yds. vibro. conc. pavement, 30 and 24 ft. wide; 27,400 lin. ft. curb and gutter, 80c; 100 lin. ft. headings, 50c; 500 lin. ft. straight curb, 60c; F. B. Corey, local, at $27,140 for 23,600 sq. yds. brick relaid.

**Ky., Frankfort**—State Hwy. Comn., Frankfort, let contracts for 3 road projects as follows: Allen Co., 10.155 miles rock asph., Scottsville-Glasgow

Rd., from Scottsville to Barren Co. line, to Billiter & Wiley, Covington, at $387,053; Laurel Co., 5.5 mi. conc., London-Mt. Vernon Rd., from Rockcastle river to F. A. P. 29, to Tovis & Ingram, Danville, at $199,725; Knox Co., 17.035 mi. conc., from Barbourville-Corbin Rd., from Barbourville to Corbin, to R. L. Peters, Knoxville, Tenn., at $555,812.

**Ky., Frankfort**—Ping Bros., Somerset, Ky., awarded contract by State Hwy. Dept. for 16 miles grading on Somerset-Whitley City Rd., at approx. $191,440.

**Ky., Irvine**—J. S. Lusk, Knoxville, Tenn., awarded contract by State Hwy. Comn., Frankfort, to grade and drain 10.941 miles Irvine-Beattyville Rd. from south corp. limits of Irvine to Lee Co. line, State Proj. 29, Sec. B, at $253,992.

**La., Lake Charles**—D. C. Ritchie, Wichita, Kan., awarded contract to pave 11 streets, at $112,000.

**La., New Orleans**—J. Reiss, Carondelet Bldg., awarded contract by Board Port Comnrs., New Courthouse Bldg., for concrete floor slab grading and paving at Claiborne Ave. landing, at $155,635.

**Mass., Boston**—Following contracts let by Div. of Hwys.: Paving 15,770 ft. highway, 18 ft., in Norwood and Walpole, rein. conc., to Alco Contg. Co., 73 Tremont St., Boston, at $203,130; 12,712 ft., 18-ft., in Lenox, rein. conc., to C. W. Blakeslee & Sons, 58 Waverly St., New Haven, Conn., at $154,017; 5,000 ft. 18-ft. in Plymouth, bitum. macadam, to R. H. Newell Co., Main St., Uxbridge, at $47,595; 34,237 ft. in Nantucket, resurfacing and widening bitum. concrete, to M. M. Roach, East Bridgewater, at $100,115.

**Miss., Belzoni**—S. A. Gano, New Orleans, La., awarded contract for bldg. 9.7 miles 18-ft. conc. highway, from Yazoo Co. line near Midnight, Miss., toward this city, at $306,000.

**Miss., Jackson**—Owens & Gaddis, Jackson, awarded contract for 3 vibrolithic roads totaling about 4 miles, at $110,915.

**Miss., Jackson**—S. A. Gano, Maison Blanche Bldg., New Orleans, La., awarded contract for paving 150,000 yds. hwy., from Yazoo County line, Midnight to Belzoni, at total cost of $306,000.

**Nev., Carson City**—Ken. Hodgman, Winnemucca, Nev., awarded contract for Proj. 56-B, for grading, constructing culverts and placing selected material surf. bet. Carroll Summit and Campbell Creek Ranch, at $103,947.

**N. J., Trenton**—D. Klockner, 1621 Nottingham Way, Trenton, awarded contract by State Hwy. Dept., Trenton, for constructing Rte. 16, Sec. 6-A, Morris and Somerset Cos., at $173,387.

**N. Y., Brooklyn**—Following contracts let by E. Riegelmann: Asph. pavement on Carroll and Crown Sts., to Borough Asphalt Paving Co., 1301 Metropolitan Ave., at $7,107 and $21,415 respectively; Ave. D, also paving and repaving Clonwood Rd. and 87th St., asph., to Brooklyn Alcatraz Asphalt Paving Co., 1301 Metropolitan Ave., at $26,765, $34,051 and $9,508, respectively; asph. paving 14th St. to Uvalde Asphalt Paving Co., 1 Broadway, New York, at $71,430; Wilson Ave., to Sicilian Asphalt Co., 41 Park Row, New York, at $32,913; grading, curbing and flagging Ave. D, to C. Bennett Contg. Co., 414 Rutland Rd., at $18,621.

**N. Y., Long Island City**—W. J. Fitzgerald, 547 W. 45th St., New York City, awarded contract for sheet asphalt repaving on Jackson Ave., at $347,719.

**N. C., Fayetteville**—P. J. McGuire, Norfolk, Va., awarded contract for 75,000 sq. yds. street paving; 30 per cent sheet asphalt and 70 per cent Warrenite bitulithic, at $300,000.

**N. C., Raleigh**—A. J. Wardrep, Knoxville, Tenn., awarded contract by State Hwy. Dept. for 10.85 miles conc. pavement on road bet. Marion and Asheville, at $210,000.

**N. C., Raleigh**—R. G. Lassiter & Co., Citizens Bank Bldg., awarded contract for paving various streets; asph. on concrete base, curbing, guttering, storm sewer, etc., at $425,000.

**Okla., Okla. City**—Southern Constr. Co., Durant, awarded contract for grading and paving 11.73 mi. road from Norman to Okla. Co. line, F. A. P. 112; 125,857 sq. yds. asph., 56,287 c. y. earth, 571 c. y. rock excav., at $329,765.

**Pa., Harrisburg**—State Hwy. Dept. let contracts as follows for road work: Constructing 13,453 ft. Rte. 187, Sec. 4-A, Westmoreland Co., and 25,693 ft. Rte. 187, Sec. 4-B, Westmoreland Co., to Corrado & Galliardi, Connellsville, at $146,702 and $261,844 respectively; 18,421 ft. Rte. 54, Indiana Co., to M. Bennett & Sons, Indiana, at $201,989; 16,948 ft. Rte. 109, Application 2678 and 2710, Greene Co., to S. Gamble Co., Glass St., Carnegie, at $227,097; 1,805 ft. Rte. 180, Delaware Co., to Juniata Co., Empire Bldg., Phila., at $33,124; 7,424 ft. Rte. 1, Application 2136, Northumberland Co., to Reitz Bros., Sunbury, at $52,024; 4.151 ft., Application 4151, Jefferson Co., to G. I. Thompson Co., Clearfield, at $39,710; 10,530 ft. Rte. 204, Beaver Co., to W. S. Morrison, New Brighton, at $119,816.

**Utah, Salt Lake City**—P. J. Moran, Inc., 850 S. 2nd St., W., awarded contract for paving 4 miles Bingham Highway-Atwells Crossing, 18-ft., 6 in. conc., at $105,000.

**Tex., Bonham**—Julian G. Field & Co., Denison, Tex., awarded contract by Fannin Co. for 7.35 miles concrete rd. on State Hwy. No. 5, at $275,000.

**Tex., Corpus Christi**—Smith Bros., Dallas, Tex., awarded contract to build 10.1 miles hwy., State Hwy No. 12, at $286,062.

**Tex., Del Rio**—W. T. Montgomery, San Antonio, awarded contract at $93,733 to grade, construct drainage structs. and gravel surface 12.74 miles road from 12 mi. north of Del Rio on Sonora road to intersection of Sonora and Rock Springs roads.

**Tex., La Grange**—W. H. Davis, La Grange, awarded contract to grade, construct drainage structs. and gravel 2 sects. of roads as follows: 1.69 mi. in La Grange, at $14,250; 5.84 mi. State Hwy. 3-B, to new brdg. to be built across Colorado river so. of La Grange, at $96,250.

**Va., Richmond**—State Hwy. Comn. let contract for 3 roads as follows: Coast Capitol Hwy., Richmond to Seven Pines, to McGuire & Rolfe, Richmond, at $136,254; bitum. macadam roadway, 3 miles east of Radford, to Pendleton Construction Co. and Albert Bros., of Shawesville, at $79,846; Rte. 39, Bottom's bridge to New Kent Courthouse, to Battershill & Goode, Charlottesville, at $100,000.

**Wash., Spokane**—Following contracts let by Spokane County: Campbell and Barr, 8.1 miles, Deer Park-Milan rd., at $60,233; Triangle Construction Co.: 5.6 mi. Cheney-Plaza Rd., at $68,091; Triangle Constr. Co., 7.8 mi. Blanchard Rd., at $108,752.

**Wash., Seattle**—Goetz & Brennan, Seattle, awarded contract for grading, paving, etc., Youngstown Pl., et al., at $359,004.

**W. Va., Buckhannon**—Marshall & Hillooly, Elkins, awarded contract for grading and conc. paving 7.04 miles, Clarksburg Pike to Barbour Co. line, at $354,675.

## SEWERAGE AND SEWAGE TREATMENT

**Cal., Long Beach**—Pernel Barnett, 630 E. Washington St., Orange, awarded contract for constructing concrete pipe sewer with brick manholes in Frontenac St., at $6,622; United Concrete Pipe Co., Box 6, Ventura, awarded contract for constructing the Golden Ave. storm sewer, at $165,000. Sewer pipe will consist of reinf. conc. pipe of sizes from 14 to 42 inches in diam.

**Cal., Los Angeles**—Following contracts let by Board of Public Wks.: Constructing following sections of North Outfall Sewer: 11,050 lin. ft. semi-elliptical sewer, 10 ft. 6 in. depth, Sec. 4, to Ross Construction Co., Van Nuys Hotel, at $303,300; 15,197 lin. ft. semi-ellipt. sewer, Sec. 6, to Callahan & Cooney, Laughlin Bldg., at $298,000; 10,906 lin. ft. semi-ellipt. sewer, Sec. 8, to L. S. Atkinson, Jr., Chapman Bldg., at $249,500; 6,294 lin. ft. semi-elliptical type, Sec. 9, to Kelly & Sons, 815 Hill St., at $165,516.

**Cal., Morgan Hill**—Heafey-Moore-McNair, 2030 High St., Oakland, awarded contract for sewerage system at $51,296.

**Kans., Great Bend**—T. Johnson, Eagle Grove, Iowa, awarded contr. for sewerage system; 16,500 ft. trench 8 ft. deep, 6,300 ft. trench 8 to 12 ft. deep; 11,500 ft. wet trench, 0 to 3 ft. of water; also 2,400 lin. ft. 18-in., 4,950 lin. ft. 15-in. and 14,500 lin. ft. 24-in. lock joint rein. conc. pipe, at $75,462.

**La., Baton Rouge**—J. B. McCrary Co., Atlanta, Ga., awarded contract to construct approx. half of the new sewer system, at $126,854.

**Mo., Maplewood**—Blackburn & Crean, Chouteau Trust Bldg., St. Louis, awarded contract for 9,800 ft. 8-36 in. vit. clay and 200 ft. 42-in. segmental blk. sewer in Laclede Rd., Dist. Sewer 1, at $90,635.

**Mich., Detroit**—Miller-York, Inc., 1523 E. Congress St., awarded contract for pumps, motors, air

compressors, etc., in sewage pumping station, at $74,900.

**Md., Baltimore**—Aiello Constr. Co., 4th & Gough Sts., awarded contract by Bd. of Awards for 4,200 ft. 8 to 27-in. san. sewers, Dist. 24-B, Trunk Sewer, San. Contr. 208, at $131,000.

**Md., Baltimore**—A. J. Boyle, 314 American Bldg., awarded contract for 6,400 ft. 8 to 48-in. san. sewers and storm drains in Dists. 50 and G-11, Storm Water Contr. 63, at $48,910.

**Mo., Farmington**—Welp & Zigrang, Bancroft, Ia., awarded contract for 62,862 ft. 8 to 15-inch vit. pipe sewer, 36 ft. 8-15 in. cast iron pipe, disposal plant, etc., at $81,582.

**N. Y., Johnson City**—Contracts for 8,060 ft. 24 to 42-in. rein. conc., 90 ft. 20-in cast iron and 712 ft. 8-20 in. vit. clay sewers and 690 ft. 6-in. vit. clay laterals in Riverside Dr., to Willow, Grand, Lincoln and Division Sts., Burbank and Farr Aves., to C. Rose, 807 Chenango St., Port Dickinson, at $64,138.

**N. Y., Long Isl. City**—Contract for reconstructing outlet sewers in lines of (1) 42nd and (2) 51st Sts., Flushing Bay, etc., to A. M. Hazell, Inc., 26 Cortlandt St., New York, (1) $35,380; to J. D. Walsh, Inc., 132 4th St., Brooklyn, (2) $44,980. Following contracts let by Pres. Bronx Boro: Sewers in Zulette Ave., to MacDonald & Wilson, $17,937; Findlay Ave., to J. V. Timoney Constr. Co., 220 E. 201st St., $11,502; Melville St., to F. Gasparino, $41,108; Rhinelander and Wilson Aves., to A. Gregorio & Co., $59,942 and $28,252 respectively.

**N. D., Fargo**—Haggart Constr. Co., Fargo, awarded contract for sewers at $47,919; water main extension at $10,842.

**O., Cincinnati**—Cannel & Conrad, 2907 Madison Rd., awarded contr. for constructing sewer in Duck Creek, bet. Williams and Dana Sts., at $194,-774.

**Okla., Okla. City**—Municipal Excavator Co., 200 E. Main St., awarded contract for new storm sewer, 7,669 ft. 15-in. to 60-in. concrete pipe, in Broadway, Pottawatomie, Robinson and Harvey Sts., at $57,949.

**Okla., Stroud**—H. L. Canaday Co., Tulsa, Okla., awarded contract for main san. sewers, sewage disposal plant and san. lateral sewers, at $94,622.

**S. C., Inman**—Ryan Engrg. Co., Columbia, S. C., awarded contr. to construct sewerage and water system at abt. $100,500.

**Tex., Dallas**—R. J. Estep Co., Deer Bldg., Dallas, awarded contract to construct extension of municipal sewage disposal plant on Hutchins Rd., at $200,000; 12 Imhoff tanks.

**Tex., Park Place**—(Harrisburg P. O.) General Excavation Co., Magnolia Blvd., Dallas, awarded contract for disp. plant and sewers, at $94,820.

**W. Va., Bluefield**—J. W. Vaughan & Co., Roanoke, awarded contract for san. sewers, inlets, etc., at $200,000; ditch work, etc., to Pace Constr. Co., Roanoke, at $15,000.

## WATER SUPPLY AND PURIFICATION

**Cal., Glendale**—Kinne & Westerhouse, 636 H. W. Hellman Bldg., Los Angeles, awarded contract for constr. of 15,000,000-gal. reservoir, at $78,560.

**Ont., Amherstburg**—Duff & Carnahan, Amherstburg, awarded contract for 2 miles 1½ and 2-in. water pipe, at $30,000.

**Ont., Ford**—Following contracts have been awarded in connection with filtration plant to be built here: General contract to Strain & Emery, Ltd., Windsor, at $350,582; 42-in. steel pipe, $7,680, to Toronto Iron Works, Ltd.; cast iron pipe and special castings, $8,389, also valves and sluice gates, $26,782, Francis Hankin & Co., Ltd., Toronto; controlling and operating tables, $12,325, Canadian International Filters Co., Ltd., Toronto.

**Ont., Toronto**—F. Hankin & Co., Ltd., 386 King St., W., awarded contract for 20,000 lin. ft. 20-in. and up cast iron pipe, at $228,220.

**Ont., Windsor**—Strain & Emery, Dowler Bldg., awarded contract for filtration plant, at $350,000.

**Colo., Denver**—W. O. Morrison, 403 Cooper Bldg., awarded contract by Bd. of Commrs. for conduit constr., exclusive of excavation and backfill, at $1.78 per lin. ft.; excav. and backfill only for entire conduit to E. H. Honne, Box 72, Colorado Springs, at $3.28 per lin. ft., etc., etc. Other contracts for water works impvts. let as follows: 27,384 ft. 36-48-in. pipe, 91, 160 lb. Y branches, 5,130 lb. wd. to iron, 145,804 lb., all other specials, to U. S. Cast Iron Pipe & Fdry. Co., 122 S. Michigan Ave., Chicago, at $424,628; 22 24-60-in. hub-end, two 60-in. hydraulic and two 60-in. electric horizontal valves to Hendrie & Bolthoff, 1639 17th St., at $51,365; 1,484.7 tons 20-24-in. pipe to Colorado Fuel & Iron Co., Boston Bldg., at $95,021.

**Md., Baltimore**—R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa., awarded contract for furnishing and delivering cast iron pipe and fittings for Water Dept., at $234,389.

**Mont., Kalispell**—U. S. Cast Iron Pipe and Foundry Co., 122 S. Michigan Ave., Chicago, awarded contract for renewal of water mains on Railroad St., 4th Ave. to E. 8th, at total cost of abt. $40,000.

**Neb., Fremont**—Following contracts let: Turbo generator, condenser, Allis-Chalmers Mfg. Co., 321 N. 8th St., Lincoln, at $29,260; pumps, meters, to Worthington Mach. Co., New York City, at $7,850.

**N. J., Clifton**—Turbine Equipment Co., 30 Church St., New York City, awarded contract for pumping machinery and equipment for Yantacaw pumping sta. here, at $27,775.

**N. J., Kearney**—(Arlington P. O.) Nesto Construction Co., 685 Broad St., Newark, awarded contract for constructing part of Meadows water system, known as steel main, in Jacobus Ave., at $52,800.

**N. C., Conover**—Tucker & Laxton, Inc., Realty Bldg., Charlotte, awarded contract for water and sewerage systems at $30,250, exclusive of cost of water works materials, which will be furnished by town.

**N. C., Greeensboro**—Ocie Dasheall Co., Portsmouth, Va., awarded contr. for 7½ miles cast iron mains bet. here and city reservoir, at $72,000.

**N. C., Laurinburg**—Tucker & Laxton, Charlotte, N. C., award. contr. for water works system, which includes constr. work for pumping station, filtering plant, reservoir, auxiliary station, laying pipe line, furnishing pumps, etc.; Carolina Willys Light Co., Laurinburg, will construct 3-phase copper wire power transmission lines; Chicago Bridge and Iron Works has contract for wash water tank; American Cast Iron Pipe Co., Birmingham, contr. for cast iron pipe; Grinnell Company, contract for valves. Contract price, $45,661.84.

**O., Cleveland**—Winterbottom-Connolly Co., 2997 Meadowbrook Blvd., Cleveland Heights, awarded contract for 30-in. and 24-in. cast iron mains in Woodhill Rd. Contr. 32, Secs. N and S, at $126,690 and $117,645, respectively.

**Ohio, Toledo**—Dravo-Doyle Co., Diamond Bldg., Pittsburgh, awarded contract for synchronous motor driven centrif. pump, 35 m.g. capy., at $26,000.

**O., Youngstown**—Burnip Constr. Co., 223 E. Broad St., Columbus, awarded contract for 1 m. g. filtration plant at Burgess Lake, at $100,000.

**R. I., Providence**—J. Livingstone Co., 70 East 45th St., New York City, awarded contract for grubbing, earth and rock excav., in preparation for Scituate reservoir, in Scituate, at $254,410.

**S. C., Inman**—Ryan Engineering Co., Columbia, S. C., awarded contract to construct water and sewerage system, at $100,000.

**S. C., Laurinburg**—Tucker & Laxton, Charlotte, N. C., awarded contr. for pumping station, reservoir and filtration plant at about $148,000.

**S. D., Millbank**—Phelps-Drake Co., 623 Metropolitan Life Bldg., Minneapolis, awarded contract for constr. of pipe line here, at $94,018; 47,600 ft. 8 and 10-in. cast iron pipe.

**Tex., Dallas**—R. J. Estep Co. awarded contract to construct extension of municipal sewage disposal plant on Hutchins Rd., at $200,000.

**Texas, Dallas**—J. C. Winslett, 1001½ Main St., awarded contr. by Beverly Hills Fresh Water Dist. for main extensions, including 102,500 ft. 2-8 inch pipe, at $35,000.

**W. Va., Keyser**—Pfhl & Miller awarded contract for $161,500 for filtration plant, including grading and concrete work for filter plant and pumping station, $35,000; substruct. of pump sta. and filter plant, $18,200; booster pump sta., tank fittings and lot grading, $84,000; piping, $3,200; H. L. Bayard & Co., $33,000 for filter equipment; Chicago Bridge & Iron Co., Chicago, Ill., at $12,425 for steel reservoir tank, and at $9,925 for elevated tank; also other contracts to H. C. Brooks Co., Martinsburg; Fairbanks, Morse & Co., Chicago, and Franklin Electrical Construction Co.

# Prospective Work

## ROADS AND STREETS

**Ala., Mobile**—City plans to expend $300,000 to pave 13 streets, including Broad, Texas to Baltimore; Washington Ave., Baltimore to L. & N. crossing; Houston, Government to Dauphin; Elmira, Ann to Rapier; Catherine, Dauphin to St. Stephens Rd., etc.

**Ark., Eureka Springs**—State Hwy. Dept., Jefferson City, Missouri, will let contract within next 60 days for construction of a hard surfaced road from Washburn, Mo., to connect with the Ark. Hwy. south of Seligman.

**Cal., Los Angeles**—Los Angeles County plans expendt. of $60,000,000 worth of construction work for 1924. Some of the work is just being started. County has tentative road impvt. program that will aggregate approx. $5,000,000, according to estimates by Geo. W. Jones, Co. Rd. Commr. This comprises cash jobs totaling abt. $1,750,000, 10 impvts. under the Rd. Dist. Impvt. Act of 1907, and about 45 sidewalk, curb and street jobs under Co. Impvt. Act of 1921. These impvts. involve orders for abt. 2,000,000 sq. ft. walk, 500,000 lin. ft. curb, 760,000 sq. yds. cement concrete pavement, 405,000 sq. yds. asphalt conc. pavement, 3,000 sq. yds. macadam, 252,000 sq. yds. oil and rock screenings surface, 874,000 sq. ft. concrete gutter, 71,000 sq. yds. Willite, and 53,400 sq. yds. National pavement. Bridges costing $270,000 will probably be built during year. City of Los Angeles pans big impvt. program. City Engrg. Department has orders from Council for paving 148 miles, grading and oiling 46 miles of streets. During 1924 at least 90 miles of streets will be paved and 30 miles graded and oiled. If efforts of Engrg. Dept. prevail work will also be started during 1924 on 6 viaducts over Los Angeles river at est. cost of about $10,000,000. Pians complete and city has voted bonds. Progress temporarily retarded by failure of the railroads to agree on financing their portion. State Hwy. program will total probably $15,000,000, according to Harvey M. Toy, Chrmn. of State Comn., Sacramento.

**Fla., Bartow**—Polk County considering constr. of 106 miles 15-ft. asphalt road and widening 9-ft. rds. to 15-ft. Election Feb. 26 on $3,600,000 bonds. W. S. Wey, Deputy Clk. Board of Co. Commrs.

**Fla., Ocala**—Marion Co. plans highway impvts. Contemplates voting on $1,250,000 bonds. J. C. Walker, Co. Engr.

**Ia., Davenport**—City considering paving about 60 streets and alleys during 1924. H. R. Phillips, Supt. PPub. Construction. I. W. Christensen, City Clerk.

**La., Bastrop**—Morehouse Parish plans expendt. of approx. $350,000 to build highways in parish, including rd. through 9th Ward from Mer Rouge to Collinston and thence to Wham to connect Monroe-Bastrop hwy. in Ouachita Parish and Ward's Ferry road through 2nd Ward.

**La., Baton Rouge**—La. Hwy. Comn., Reymond Bldg., Baton Rouge, plans bldg. 31 miles highway, including road from Natchitoches Parish to Caddo Parish.

**Md., Baltimore**—City (Howard W. Jackson, Mayor) plans following impvts.: Bridges, $3,000,000; sewers, $10,000,000; pavingg, $5,000,000; conduits, $1,000,000. Considering $19,500,000 bond issue.

**Mich., Royal Oak**—Village Commission ,acting on recommendation of special committee, has authorized condemnation of strip of property on east side of Main St., for purpose of widening that thoroughfare. Est. cost of impvt., $300,000.

**Minn., Montevideo**—Ready for bids about March 16 for grading to cost about $19,000; also ready for bids abt. March 16 for road work in Chippewa Co. Engr., R. G. Michie, Montevideo; A. E. Swenson, Co. Aud. Est. cost of last mentioned proj., $394,-000.

**Miss., Jackson**—City and Illinois Central R. R. Co. are planning to repave streets and elevate R. R. tracks. Approximate cost, $1,250,000 to $1,500,000. F. L. Thompson, Chf. Engr. I. C. R. R., Chicago, Ill.; M. L. Culley, City Engr.

**Neb,, Chadron**—Will call for bids in near future for paving 19 blocks here. Est. cost, $500,000. G. E. Mariott, City Clerk.

**N. D., Devils Lake**—Following are road impvts. authorized in county during 1924: Construct 12 miles of road N., S. and E. of Edmore; gravel 13 miles W. on Edmore-Starkweather project; gravel Edmore Rd. 9 mil. west of Edmore, 6 miles; grade highway from Starkweather south into Devils Lake. J. A. Kramer, Co. Aud.

**Ohio, Lisbon**—Columbiana County contemplates constr. of 2 mi. or more Fairfield-Elkron-Middleton Twp. Rd., 20 ft. Est. cost, $150,000. Will mature in spring. L. C. Kirk, Lisbon, Engr.

**Okla., Blackwell**—City plans to grade and pave 29 blocks College, Pason, Bridge and McKinley Sts.; 26,000 sq. yds. concrete, 11,800 lin. ft. curbing, 8,600 cu. yds. earth and 100 c. y. rock excav. Est. cost $105,000. W. Ritzhaupt, Jr., Blackwell, Engr.

**Okla., Chickasha**—Grady Co. plans to build hard surf. roads and bridges in county. Election Mch. 4th to vote on $1,000,000 bonds.

**Okla., Okla. City**—State Hwy. Comn. plans to complete hard surf. roads. Considering voting in 1924 on $75,000,000 bonds.

**Okla., Tulsa**—City preparing plans for grading, paving, curbing and guttering 19,000 ft. 12th Pl., Lewis, Boston, 8th, Wheeler, 20th, Zunis and St. Louis Sts.; brick, concrete, asph. conc., etc. Est. cost $180,000. C. Schultz, City Engr.

**S. C., Charleston**—Charleston Co. San. & Drainage Comn. plans to concrete 8 miles Blue House Rd., end of present concrete to Dorchester and Berkeley County lines on rte. to Summerville and to Santee River Hwy. Est. cost $250,000.

**S. D., Pierre**—Will let contract in March for 13.8 miles grading and draining in Hand Co., bet. St. Lawrence and Wessington .

**S. D., Sioux Falls**—City will pave 44½ blocks and petition made for 52 additional blocks—total 8 miles. Walter Leyse, City Clerk.

**Tenn., Jackson**—Madison Co. Court plans to construct 5 hard surf. roads in county; $600,000 bond issue authorized.

**Texas, Austin**—State Hwy. Dept., Austin, approved plans to surf. with shell base and bitum. top 1.56 miles State Hwy. No. 3, Harris Co., bet. Almeda and Ft. Bend Co. line. Est. cost $36,500. Howe & Wise, Engrs., 211 1st National Bank Bldg.; Chester H. Bryan, Co. Judge, both Houston. Rock Springs—Edwards County will receive bids in near future to gravel surf. 17.13 mi. State Hwy. 41, Real Co. line to point 4½ miles from here, F. A. P. 335. Est. cost $155,000; F. A., $50,000. W. E. Simpson, Co. Engr. National Bank of Com. Bldg., San Antonio; A. P. Allison, Co. Judge, Rock Springs. Tyler—Smith Co. plans 3 miles 18--ft. conc. pavement on State Hwy. 64, F. A. P. 423. Est. cost $100,000; F. A., $45,000. D. K. Caldwell, Co., Engr.; D. R. Pendleton, Co. Judge. Carrizo Springs—Dimmitt Co. plans 50 miles gravel surf. rd. on State Hwy. 85. Est. cost $248,000. J. Guy Lott, Co. Engr.; Wm. H. Davis, Co. Judge.

**Tex., Austin**—$1,500,000 bonds voted here by Travis County. Geo. Matthews, Judge.

**Texas, Alice**—Jim. Wells Co. plans 2 rd. propects as follows: 83.3 miles Laredo-Corpus Christi Hwy., State Hwy. 12-B, from Duval Co. line to Nueces Co. line. Est. cost $1,263,000. 65 miles State Hwy. 12-A, San Patricio Co. line to Brooks Co. line. Est. cost $1,230,000. L. W. Scheider, Mantel, Co. Engr. R. R. Mullin, Co. Judge.

**Texas, Baird**—Callahan County plans to construct 2 road projects as follows: 33 miles bitum. macadam on Bankhead Hwy., Eastland Co. line to Taylor Co. line; approximate cost $562,000. 9.7 miles from Mexia Creek to Eastland Co. line; est. cost $182,750. T. H. Webb, Co. Engr.; Victor B. Gilbert, Co. Judge.

**Texas, Dallas**—City considering gravel surfacing side streets, perm. pavingg traffic streets, and storm sewers in Oak Cliff, including Oak Cliff Blvd., W., W. 12th and Jefferson Sts. Est. cost $150,000. Plans prepared for widening and paving Live Oak St., 50 to 70 ft., $471,710; Harwood St., 45-60 ft., $432,000; Lamar St., $175,000; Cockrell St., $160,000. E. A. Woods, City Planning Engr. Gravel or macadam surfacing also planned including guttering and curbing Broadmoor, Britton, Saner and miscellaneous streets. Estimated cost, $25,000. City will soon receive bids for paving 15 streets, bitum. conc. or brick, $400,000. E. A. Kingsley, City Engr.

**Texas, Lubbock**—City considering expending $1.-

# BUYERS' GUIDE

**Aerial Tramways.**
American Steel & Wire Co.

**Air Lift Pumps.**
Harris Air Pump Co.

**Armor Plates.**
Truscon Steel Co.

**Asphalt.**
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

**Asphalt Filler.**
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

**Asphalt Floors.**
The Barrett Co.
The Texas Co.
Warren Bros. Co.

**Asphalt Machinery.**
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

**Asphalt Plants.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

**Asphalt Railroad Plants.**
Cummer & Son Co., The F. D.
Warren Bros. Co.

**Asphalt Tools.**
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

**Asphalt Tool Wagons.**
Chausse Oil Burner Co.
Littleford Brothers.

**Auto Fire Apparatus.**
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Back Fillers.**
Austin Machinery Corporation.
Pawling & Harnischfeger.

**Bar Cutters and Benders.**
Koehring Machine Co.

**Bars, Reinforcing.**
Truscon Steel Co.

**Binders, Road.**
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

**Bitulithic Pavements.**
Warren Bros Co.

**Blasting Accessories.**
E. I. du Pont de Nemours & Co., Inc.

**Blasting Powder.**
E. I. du Pont de Nemours & Co., Inc.

**Bodies.**
Lee Trailer and Body Co.
Littleford Brothers.

**Braces, Extension.**
Kalamazoo Fdy. & Machine Co.

**Brick Rattlers.**
Olsen & Co., Tinius.

**Brick-Testing Machinery.**
Tinius Olsen Testing Mach. Co.

**Bridges.**
Lewis-Hall Iron Works.

**Buckets, Dredging, Excavating and Sewer.**
Pawling & Harnischfeger.

**Buckets, Dumping.**
Littleford Brothers.
Pawling & Harnischfeger.

**Cableway Accessories.**
Sauerman Bros.

**Cableway Excavators.**
Sauerman Bros.

**Calculators.**
Kolesch & Co.

**Car Unloaders.**
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

**Castings.**
U. S. Cast Iron Pipe & Fdy. Co.

**Cast Iron Pipe.**
U. S. Cast Iron Pipe & Fdy. Co.

**Catchbasins.**
Dee Co., Wm. E.
Madison Foundry Co.

**Cement Testing.**
Kirschbraun, Lester.

**Cement Testing Machinery.**
Tinius Olsen Testing Mach. Co.

**Central Heating Plants.**
American District Steam Co.

**Chimneys, Concrete.**
Truscon Steel Co.

**Chimneys, Steel.**
Lewis-Hall Iron Works.
Littleford Brothers.

**Chloride of Lime.**
Pennsylvania Salt Mfg. Co.

**Chutes, Concrete.**
Heltzel Steel Form & Iron Co.
Littleford Brothers.

**Concrete Mixers.**
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

**Concrete, Reinforcement.**
American Steel & Wire Co.
Truscon Steel Co.

**Conduits.**
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

**Conduit Rods.**
Stewart, W. H.

**Consulting Engineers.**
Alvord, John W.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

**Contractors.**
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

**Contractors' Tools and Machinery.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

**Contractors' Wagons.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

**Conveying Machinery.**
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

**Cranes and Hoists.**
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

**Creosote.**
The Barrett Co.
Republic Creosoting Co.

**Creosoted Wood Block.**
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

**Crushers, Rock and Ore.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Culvert Pipe, Vitrified.**
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

**Culverts.**
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

**Curb and Gutter Forms.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Curb Bar.**
Truscon Steel Co.

**Direct Oxidation Process.**
Direct Oxidation Process Corp.

**Drag-Line Excavators.**
Austin Machinery Corporation.

**Drag Scrapers.**
Austin-Western Road Machinery Co.

**Drain Tile.**
Dee Clay Mfg Co., W. E.

**Drawing Materials.**
Kolesch & Co.

**Dryers.**
Cummer & Son., The F. D.

**Dump Cars.**
Austin-Western Road Machinery Co.

**Dump Wagons.**
Austin-Western Road Machinery Co.

000,000 for street paving. Hawley and Roberts, Engrs., Ft. Worth and Dallas, will design and supervise project.

**Texas, Mexia**—Freestone County considering building roads. Voted $1,000,000 bonds.

**Texas, Sulphur Springs**—Hopkins Co. plans to build 2 roads as follows: 24.9 mi. Bankhead Hwy., from Hunt Co. line to west line Rd. Dist. 17; macadam base surf. inverted penetration bitum. topping; est. cost $545,600. 7.8 mi. State Hwy. No. 1, Jefferson Rd., from east line Rd. Dist. No. 8 to Franklin Co. line; macadam base, inverted penetration bitum. topping; est. cost, $195,400. J. B. Rieman, Co. Engr.; R. E. Bertram, Co. Judge.

**Wash., Chehalis**—Roy L. Greene, Engr., Lewis Co., states that approx. $188,000 will be available in 1924 from various Rd. Dists., mostly for grading and surfacing with gravel and crushed rock with a like sum available for similar work in 1924. State will pave, in near future, National Park hwy.—Ethel to Silver Creek. It is also expected to pave about 1 mile from Centralia, permanent hwy. fund to meet the cost.

**Wn., Olympia**—New hwy. construction planned by State Hwy. Dept. for 1924 includes bldg. 51 miles conc. hwy. and grading and surfacing 60 miles of roadway, with all bridges necessary. Est. cost $6,470,000. Tentative dates for opening various bids are as follows: Jan. 26, Clear'g 48 mi. Olympia Hwy.; Mch. 11, Grad'g 3 mi. Pacific Hwy. Marysville to Everett and 14 mi. Everett to Seattle; Pav'g 16 mi. Oympic Hwy.; grading and gravel'g 7 or 8 mi. Navy Yard Hwy., grad'g 7 mi. Inland Empire Hwy. Mch. 18: Pav'g 3½ mi. hwy. from Anacortes east in Skagit Co.; Gravel'g 4 mi. National Park Hwy, Lewis Co.; grading and graveling 4 mi., Ocean Beach Hwy, Lewis Co.; grad'g and gravel'g 3 mi. No. Bank Hwy. Skamania Co.; grad'g and gravel'g 3 mi. Olympia Hwy. Clalla Co. Mch. 25: Grad'g 4 mi. and graveling 10 mi. No. Central Hwy., Kittitas Co., grad'g and graveling 4 mi. Tonasket-San Poll Hwy., Okanogan Co., grad'g and gravel'g 4 mi. State Rd. No. 22, Stevens Co.; grad'g 2 mi. Sunset Hwy., Chelan Co., grad'g 3 mi. Central Wash. Hwy. nr. Four Lakes, Spokane Co.; grad'g and gravel'g 3 mi. Methow Valley Hwy., Okanogan Co. May 20: Grad'g and gravel'g 8 mi. National Parks Hwy., Yakima Co.; grad'g and gravel'g 4 mi. National Parks Hwy., Lewie Co.; grad'g 5 mi. Ocean Beach Hwy., Lewis Co.; paving 5 mi. Inland Empire Hwy., Whitman Co.; pav'g 5½ mi. Inland Empire Hwy., Yakima Co.; paving 4 mi. National Parks Hwy., Lewis Co. May 27: Constr. of Nooksack river brdg., Whatcom Co., Pacific Hwy.; pav'g 4 mi. Inland Empire Hwy. so. in Spokane Co.; grad'g 3 mi. Pacific Hwy., Snohomish Co.; grad'g 3 mi. Sunset Hwy., Kin. Co.; pav'g 6 mi. National Park Hwy. bet. Jct. and National forest line, Pierce Co.; grading 10 mi. Pacific Hwy., Pierce Co.; grading 4 mi. Inland Empire Hwy., Walla Walla Co. June 3rd: Grade 8 mi. Olympia Hwy., Mason Co.; construct brdg. over Moss Crk., Olympia Hwy., Clallan Co.; pave six-tenths mi. gap, Pacific Hwy. at LaCenter, Clarke Co.; grade 3 mi. No. Bank Hwy. Washougal to Skamania Co. line, Clarke Co.; pave 5½ mi. Inland Empire Hwy., Walla Walla Co.; grade 8 mi. Chelan and Okanegan Hwy., Chelan Co.; construct Odessa bridge on No. Central Hwy., Lincoln Co. and pave 3 mi. Central Wash. Hwy. near Four Lakes, Spokane County. James Allen, State Hwy. Engr.

**W. Va., Bluefield**—City considering paving 34 streets and repaving 6 streets, including Fulton, Carroll, Pearl, Stowers, Cherry, 4th, Augusta Sts., and Bluefield, Princeton and College Aves. Mr. Ridley, City Manager.

**Wis., Madison**—Fed. Aid projects selected for 1924 impvt. by Hwy. Comn. are as follows: Ripon-Fond du Lac Rd., Fond du Lac Co., conc. surf. County funds, $87,500, fed. funds, $87,500—total $175,000. Portage-Kilbourn Rd., Columbia Co.: grade, culvts. and grav. surf. Co. funds, $50,000, state funds, $50,000 and fed. funds $100,000—total $200,000. Kilbourn Rd., Kenosha Co.: Conc. surf. County funds, $38,000, State funds, $25,000 and fed. funds, $63,000—Total, $126,000. Minn. Junction-Waupun Rd., Dodge Co., conc. surf. $240,000. Co. funds and $130,000 fed. funds—total $370,000. So. Fond du Lac Rd. from Milwaukee Co. line to Menomonee Falls, 3½ miles conc., $105,000. Conc. State trunk hwy. 17, so. of Sheboygan abt. 10 mi. $300,000. Conc. surf. trunk hwy. 10 from Marathon Co. line no. to Mosinee, about 7 miles, $210,000; Browntown Rd., Green Co. conc. surf. abt. 2 miles of conc. Co. funds, $50,000, fed. aid funds, $50,000—total $100,000. Rock cut at Juda and relocation along railroad track. Co. funds $30,0000, fed. funds, $34,000—total $68,000. A. R. Hirst, State Hwy. Engr. Total road funds available in Wisconsin for 1924 road construction and maintenance are as follows: Fed. Aid constr., $4,000,000; State Aid construction, including bond issue work, $3,500,000; Maint., $2,500,000—Total, $10,000,000.

**Wis. Wisconsin Rapids**—Plans under way for concrete paving. Will probably call for bids in February or March. Abt. 6 miles plain conc. 16 and 18 ft. roadways. F. F. Mengel, State Div. Engr., Wisc. Rapids.

## SEWERAGE AND SEWAGE TREATMENT

**Ala., Birmingham**—City will begin construction work on supplementary sewer project, to cost about $275,000, about April 15th. A. J. Hawkins, City Engr.

**Ark., Atkins**—Water works and sewerage system will be constructed here. Bonds $100,000. E. A. Williams, Res. Engr.; Ford & MacCrea, Gazette Bldg., Little Rock, Cons. Engrs.

**Cal., Los Angeles**—Burns & McDonnell, Marsh-Strong Bldg., Los Angeles, will proceed with final plans for outfall sewer and intercepting mains for Glendale, California. Election held recently and $1,650,000 voted for impvt. It is expected bids will be advertised about March 15th.

**Cal., Pasadena**—The $125,000 outfall sewer bond issue carried at recent election.

**Cal., Pasadena**—Board of City Directors has formally applied to Bd. Co. Supvrs. for permission to construct and maintain pipe line from City Farm to Rio Hondo, to carry clarified effluent from activated sludge plant in operation. Proposed right-of-way for line is on Saxon Ave. bet. New Ave. and Del Mar Ave., Southern Ave. to San Gabriel Blvd., thence east on the blvd. to Garvey Rd., thence so. to the Rio Hondo.

**Ont., Niagara**—Plans being prepared for sewerage system in lower Niagara Falls, Stamford Twp. Est. cost, $425,000. T. R. Stokes, Portage Rd., Engr.

**Conn., Bridgeport**—City plans to construct storm sewers in N. Main St. and Bethany Chapel system. $30,000; san. and storm water sewer in Beachwood Park Sec., $75,000; storm sewer in Capitol Ave.—N. Main to Lindley Sts., $25,000; san. trunk system in Mountain Grove St., $50,000; miscel. storm and san. sewers in smaller streets throughout City. $100,000. J. A. McElroy, City Hall, Engr.

**Ill., Bensenville**—Prelim. plans being made for 20,000 ft. 8-18 in. san. sewers and disposal plant; $200,000; 10-36 in. storm water sewer, $110,000. E. Hancock, 2047 Ogden Ave., Chicago, Cons. Engr.

**Ill., Galesburg**—City considering construction of storm and sanitary sewers; also disposal plant. Est. cost $1,000,000. Pearse, Greeley & Hansen, 39 W. Adams St., Chicago, Cons. Engrs.

**Ill., Niles Center**—Sewers will be laid in Main Street here at cost of $300,000. Consoer Engrg. Co., 140 S. Dearborn St., Chicago, Engr.

**Ill., Pittsfield**—Surveys being made for complete sewerage system to be built here at cost of about $80,000. Will mature in spring. Caldwell Engrg. Co., Ayres Bank Bldg., Jacksonville, Cons. Engrs.

**Ill., Posen**—Prelim. surveys being completed for sewerage system and disposal plant here. Est. cost $200,000. E. Hancock, 2047 Ogden Ave., Chicago, Con. Engr.

**Kans., Topeka**—Will soon receive bids on 2 intercepting main sewers for town section of city. Est. cost $100,000. C. A. Haskins, Kansas City, Cons. Engr.

**Mich., Port Huron**—Plans outlined for sewerage system which will bring to city the Dunn Paper & Sulphite Company's plant, without resorting to

# BUYERS' GUIDE

**Dust Laying Compound.**
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

**Dynamite.**
E. I. du Pont de Nemours & Co., Inc.

**Edge Protector.**
Truscon Steel Co.

**Electrical Wires & Cables.**
American Steel & Wire Co.

**Elevating Graders.**
Austin-Western Road Machinery Co.

**Elevators.**
C. H. & E. Mfg. Co.

**Engineering Instruments.**
Kolesch & Co.
Lufkin Rule Co., The

**Engines.**
C. H. & E. Mfg. Co.

**Excavating Machinery.**
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

**Expansion Joint Compound.**
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

**Explosives.**
E. I. du Pont de Nemours & Co.

**Fence, Iron.**
Cincinnati Iron Fence Co.

**Fillers (Paving Joint).**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

**Fire Brick.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Flue Liners.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Forms, Sidewalks, Curb & Gutter.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Forms, Road.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Forms (Sewers & Conduits).**
Heltzel Steel Form & Iron Co.

**Forms (Wall Bldg., Construction, Etc.).**
Heltzel Steel Form & Iron Co.

**Gas Pipe.**
U. S. Cast Iron Pipe & Fdy. Co.

**Graders.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Granite Block.**
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

**Gravel Screener and Loader.**
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

**Heaters (Rock and Sand).**
Littleford Bros.

**Heating Plants, Central.**
American District Steam Co.

**Heating Wagons (Oil and Tar).**
Good Roads Machinery Co., Inc.
Littleford Bros.

**Hoists (Concrete, Gasoline and Hand).**
Pawling & Harnischfeger.

**Hoists, Electric.**
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

**Hoists, Steam.**
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

**Hot Mixers.**
F. C. Austin Machinery Co.

**Incinerators.**
William F. Morse.

**Inlets (Sewer).**
Dee Co., Wm. E.
Madison Foundry Co.

**Insulating Material.**
The Barrett Co.
Pioneer Asphalt Co.

**Joint Fillers (Paving).**
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

**Kettles (Portable).**
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

**Manhole Covers.**
Madison Foundry Co.
Dee Co., Wm. E.

**Mastic.**
The Barrett Co.
Pioneer Asphalt Co.

**Meter Boxes.**
McNutt Meter Box Co.

**Mixers, Asphalt.**
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

**Mixers, Concrete.**
Austin Machinery Corporation.
Keehring Machine Co.
T. L. Smith Co.

**Mixers—Mortar.**
C. H. & E. Mfg. Co.

**Molds (Pipe & Culvert).**
Heltzel Steel Form & Iron Co.

**Motor Fire Apparatus.**
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Motor Trucks.**
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Motor Truck Flushers, Sprinklers and Oilers.**
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Municipal Castings.**
Dee Co., Wm. E.
Madison Foundry.

**Packing.**
Pioneer Asphalt Co.

**Paints (Asphalt).**
Barrett Co., The
Pioneer Asphalt Co.

**Paving Blocks (Creosoted).**
The Barrett Co.
Republic Creosoting Co.

**Paving Brick.**
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

**Paving Contractors.**
Warren Bros. Co.

**Paving Joint Compound.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

**Paving Joint Filler.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

**Paving Machines.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

**Paving Plants (Asphalt).**
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

**Pipe Cutters.**
W. W. Stickler & Bros.

**Pipe Dip and Coatings.**
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

**Pipe Manufacturers.**
U. S. Cast Iron Pipe & Fdy. Co.

**Pitch Filler.**
The Barrett Co.
Warren Bros. Co.

**Plows (Rooter and Wing).**
Austin-Western Road Mach. Co.

**Portable Paving Plants.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

**Portable Stone Bins.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Powder (Blasting).**
E. I. du Pont de Nemours & Co., Inc.

bond issue. Company officials have been holding their construction plans in abeyance until definitely assured they would be given sewerage facilities. At later date $350,000 bond issue will be submitted to electors for constr. of trunk line sewer to benefit northern part of city, east of Gratiot Ave.

**Minn., Willmar**—Will probably take bids in spring on sewer sys., and disposal plant. H. Gunderson, Clk. Claussen & Carroll, 406 Metropolitan Bank Bldg., St. Paul, making plans.

**Miss., Columbus**—City plans 100 blocks san. sewers and 10 miles water mains. Will vote on approx. $300,000 bond issue. City also plans to improve 150 blocks of streets. Robt. L. Totten, Cons. Engr., Birmingham, Ala.; C. C. Richardson, Chrmn. Comn.

**Mo., St. Louis**—Board of Public Service making plans for No. Baden Dist. sewer—3,000 ft. 14 ft. brick horseshoe, $220,000; Ohio-Montrose relief sewer, 21,310 ft. 8-36 in. vit. clay and 2,695 ft. 42-66 in. segmental blk. pipe, 50,008 c. y. excav., etc., $500,000; Elliott and Warne relief sewers, $800,000; 2nd section of River des Peres sewer from Southwest to Knox Aves., $500,000. W. W. Horner, City Engr.

**N. J., Lambertville**—Plans being made for sewerage syste mhere. Est. cost $130,000. C. D. Pollock, 13 Park Row and A. P. Folwell, 243 W. 39th St., New York City, Cons. Engrs.

**N. Y., Hamburg**—Prelim. plans being made for sewers and disposal plant. Est. cost $350,000. G. C. Diehl, 575 Ellicott Sq. Bldg., Buffalo.

**Ohio, Kenmore**—Prelim. report submitted by R. E. Garnin, Engr., Davis & Farley Bldg., Cleveland, for disposal plant. Est. cost, $300,000.

**Ohio, Wadsworth**—Plans being made for sewage treatment plant at cost of $125,000. R. E. Garvn, Davis & Farley Bldg., Cleveland, Engrs.

**Ohio, Youngstown**—City contemplates laying about 45,000 ft. sewers in Calvary Run and Cochran Park. Est. cost $145,000. I. Turner, City Engr.

**Okla., Chickasha**—Prelim. plans being made for sewers, outlets, disposal plant and water line from tower to plant. Est. cost $70,000. J. C. Milliken, Chickasha, Engr.

**Tex., Kerrville**—$78,000 bonds voted for sewage disposal plant and sewer extensions. Municipal Engineering Co., 715 Praetorian Bldg., Dallas, Engrs.

**Tex., Lubbock**—$200,000 bonds voted for storm sewer. M. S. Ruby, City Mgr.

**Tenn., McKenzie**—Bids will be taken in near future for sewerage system. $86,000 bonds sold. City Clk., H. C. Bryant.

**Tex., San Antonio**—$100,000 bonds voted for san. sewers, also $250,000 bonds for storm sewers. I. Ewing, City Engr.

**Utah, Salt Lake City**—City plans 3½ miles 18 to 80 inch storm sewers from eastern section of City to the Jordan River, 4th South Storm Sewer. Est. cost, $250,000.

## WATER SUPPLY AND PURIFICATION

**Ala., Birmingham**—Birmingham Water Works Co. has increased capital by $5,000,000 and authorized issuance of $500,000 preferred stock to cover water works impvts. during 1924.

**Ariz., Flagstaff**—Burns & McDonnell, 415 Marsh-Strong Bldg., Los Angeles, Cons. Engrs., have representatives here conferring with engineers of Santa Fe Ry., and city regarding constr. of storage dam in Schultz Canyon. Both City and Railroad need water badly. Latter hauls approx. 100,000 gals. fresh spring water from Flagstaff to Grand Canyon, 99 miles away each day. Railroad also has under consideration construction of additional reservoirs along its Arizona lines.

**Cal., Azusa**—Azusa Water Company is considering $100,000 bond issue for distributing system in territory on San Bernardino Rd. bet. Covina and Baldwin Park.

**Ont., Brantford**—$90,000 bonds voted for extensions and impvts. to water system here. F. P. Adams, City Engr.

**N. B., Can., Fredericton**—Estimated $150,000 to cover cost of required impvts., including erection of a million gallon capy. reservoir tank and installation of new pumps. W. A. Barbour, Cons. Engr., Boston, Mass.

**Fla., Ft. Myers**—$80,000 bonds voted for extension to water mains; $130,000 for entire gas system. Geo. S. Iredell, City Engr.

**Fla., Orlando**—$525,000 bonds voted by City for water and light impvts.

**Ill., Carmi**—Having surveys made for filtration plant, dam in Little Wabash River and supply lines. Est. cost, $50,000. Caldwell Engineering Co., Ayres Bank Bldg., Jacksonville, Engrs. Will mature in Spring.

**Ill., Girard**—Surveys being made for rein. conc. dam, filtration plant and distribution mains. Est. cost $100,000. Caldwell Engrg. Co., Jacksonville, Engrs.

**Ill., Marissa**—Caldwell Engineering Co., Ayres Bank Bldg., Jacksonville, Cons. Engrs. for impounding reservoir, pumping equipment and distribution mains to be built in Marissa. Est. cost, $100,000.

**Ky., Morganfield**—City will have plans prepared and will soon let contract for extension of water works system. $120,000 bonds available. Truman Drury, Atty.

**Ky., Paducah**—Paducah Water Co. has increased capital from $300,000 to $600,000.

**La., New Orleans**—Sewerage and Water Board plans to complete improvements to water plant, including 3 miles new mains, three new 20 m. g. pumps and new steam turbine engine, etc., which will now pave way for other greatly needed improvements in Carrolton purification plant, to cost $1,000,000 or more. A. B. Woods, Engr., Sewers & Water Board.

**Minn., Moorhead**—Town contemplates improving present plant or build new plant, $125,000. Impvt. $55,000. R. G. Price, Clk.

**Minn., Willmar**—Plans being prepared for water works, power and light systems. Est. cost, $150,000. H. Gunderson, Clk. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Cons. Engrs.

**Mo., St. Louis**—Board Pub. Serv.—Edw. E. Wall, Water Commr., 312 City Hall, will expend $12,000,000 on water works construction. Plans not yet completed. Contracts will be let at different intervals for work so plant may be built in proper sequence. First installation will be 100 gals. daily; ultimate capy. 200 m. g. d. Work includes 200 m. g. d. storage reservoir, 15 miles 60-in. steel mains, filters 200 m. g. d. capy., etc. Will probably install triple expansion engines.

**N. J., Park Ridge**—Will receive bids about Feb. 15th for 13 miles cast iron mains, 1 steel standpipe, 2 pumping stations and 2 artesian wells. H. J. Harder, 129 Market St., Paterson, Engr.

**Ohio, Painesville**—City considering extending water mains, also improving water works, including new pumps. Est. cost about $100,000.

**Okla., Tulsa**—A. J. Rudd, Water Commr., will expend $252,768 for main extension and fire hydrants for outlying sections of City to connect with Spavinaw water project for which $6,800 is being expended.

**R. I., Providence**—Plans for this year on Scituate Water Works improvement formulated. Balance of $2,096,419.98 will go for contracts in near future.

**Tex., Port Arthur**—City has engaged Nagle, Witt & Rollins, to prepare preliminary plans and to supervise constr. of Shreveport drainage conduit; permanent st. paving; storm sewers and main trunk or san. sewer program and installing pumping station equipment which is added in connection with drainage plans. Other impvts., such as shell and gravel paving, water exten., incinerator, san. sewer laterals, etc., will be under supervision of City Engrg. Dept. Lately voted $1,000,000 bonds.

**Va., Norfolk**—City Mgr. Causey will recommend to City Council that water mains be extended from City to Virginia Beach. Est. cost of impvt., $220,000.

**Va., Staunton**—City considering expending $700,000 for impvts. to water works. May vote on bonds. J. H. Pilson, Mayor.

**Wash., Vancouver**—City has applied for Superft. water from So. Ford and Lewis river on Copper Crk., tributary of Columbia river, for municipal water supply. Cost of propect estimated, in application, at $450,000. Pipe line 30 miles long will be visor of Hydraulics for permission to use 15 second constructed to convey water to City.

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**Pumps.**
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

**Reinforcing For Pavements.**
American Steel and Wire Co.
Truscon Steel Co.

**Road Building Material.**
Kentucky Rock Asphalt Co.
The Texas Co.

**Road Binder.**
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

**Road Forms.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Road Graders.**
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

**Road Machinery.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

**Road Planer.**
Austin-Western Road Machinery Co., The

**Road Oil and Preservatives.**
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

**Road Rollers.**
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

**Rock Crushers.**
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

**Roofing Material.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

**Sand Dryers.**
Cummer & Son Co., The F. D.
Littleford Brothers.

**Saw Rigs.**
C. H. & E. Mfg. Co.

**Scarifiers.**
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

**Scrapers, Drag Line.**
Pawling & Harnischfeger.
Sauerman Bros.

**Scrapers, Graders, Plows, Etc.**
Austin-Western Road Machinery Co., The

**Scrapers, Power.**
Sauerman Bros.

**Sewage Treatment.**
Direct Oxidation Process Corp.

**Sewer Braces.**
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

**Sewer Cleaning Machinery.**
Stewart, W. H.

**Sewer Forms.**
Heltzel Steel Form & Iron Co.

**Sewer Pipe.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Sewer Pipe Joint Compound**
The Barrett Co.

**Sewer Rods.**
Stewart, W. H.

**Slide Rules.**
Kolesch & Co.

**Sluice Gates.**
Coldwell-Wilcox Co.

**Snow Removal Machinery.**
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

**Special Castings.**
U. S. Cast Iron Pipe & Fdy. Co.

**Sprinklers.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

**Steel Joists, Studs and Sash.**
Truscon Steel Co.

**Steel Tapes.**
Kolesch & Co.
Lufkin Rule Co., The

**Stone Crushers.**
Austin-Western Road Machinery Co., The

**Stone Elevators.**
Austin-Western Road Machinery Co., The

**Stone Spreaders.**
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

**Stone Screens.**
Austin-Western Road Machinery Co., The
Littleford Bros.

**Street Cleaning Machinery (Horse Drawn).**
Austin-Western Road Machinery Co., The

**Street Paving Material.**
The Texas Co.

**Street Sprinklers (Horse Drawn).**
Austin-Western Road Machinery Co., The

**Surface Heaters**
Chausse Oil Burner Co.

**Subgrading Machines**
Austin Machinery Corp.
The Hug Co.

**Surveyors' Instruments.**
Kolesch & Co.
Lufkin Rule Co., The

**Sweepers.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

**Tamping Machines.**
Pawling & Harnischfeger.

**Tanks, Water Supply.**
Littleford Brothers.

**Tar and Pitch**
The Barrett Co.

**Tar Heaters.**
Littleford Brothers.

**Tarvia.**
The Barrett Co.

**Testing Chemists.**
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

**Traction Engines (Oil or Kerosene).**
Austin-Western Road Mach. Co.

**Tractors.**
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

**Traffic Signals.**
Little Giant Co.

**Trailers.**
Lee Trailer and Body Co.

**Trench Braces.**
Kalamazoo Fdry. & Mach. Co.

**Trench Machinery.**
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

**Tool Heaters, Asphalt**
Chausse Oil Burner Co.

**Turbines, Steam.**
De Laval Steam Turbine Co.

**Turntables, Truck**
The Hug Co.

**Valves.**
Coldwell-Wilcox Co.

**Wall Coping.**
Cannelton Sewer Pipe Co.

**Warrenite.**
Warren Bros. Co.

**Water Main Cleaning.**
National Water Main Cleaning Co.

**Water Pipe.**
U. S. Cast Iron Pipe & Foundry Co.

**Waterproofing.**
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

**Water Purification.**
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

**Water Softener.**
The Refinite Co.

**Water Works Supplies and Equipment.**
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

**Wheeled Scrapers.**
Austin-Western Road Machinery Co.

**Wire Rope.**
American Steel & Wire Co.

**Windows (Steel).**
Truscon Steel Co.

**Wire-Cut Lug Brick.**
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

**Wood Block (Creosoted).**
Barrett Co., The
Republic Creosoting Co.

**Wood Preservatives.**
Barrett Co., The
Republic Creosoting Co.

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—Bins, Portable Stone
—Bodies, Dump Truck
—Brick Rattlers
—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
—Heaters, Tar
—Hoisting Engines
—Industrial Cars
—Industrial Track
—Manhole Covers
—Mixers, Building
—Mixers, Hot
—Mixers, Paving
—Motor Trucks (1-3 tons)
—Motor Trucks (over 3 tons)
—Oil Distributors
—Portable Conveyor
—Portable Drilling Rigs
—Pile Drivers
—Pumps
—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
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SLAB construction—monolithic construction—of a roadway, no matter what the material used, is a very nearly hopeless attempt to conquer natural forces. Even lavish expenditure of money does not wholly guarantee endurance.

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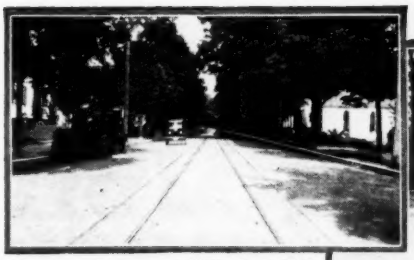
Road 64, Orange, N. J. Built 1915.



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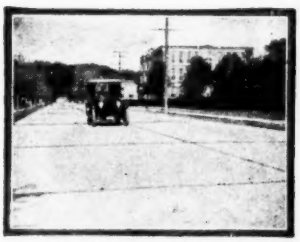

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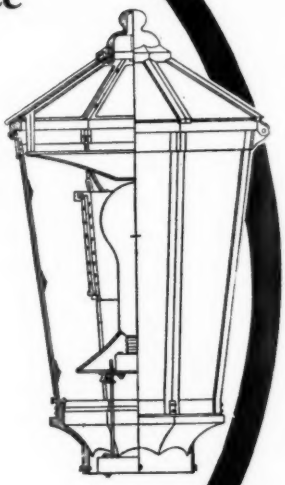

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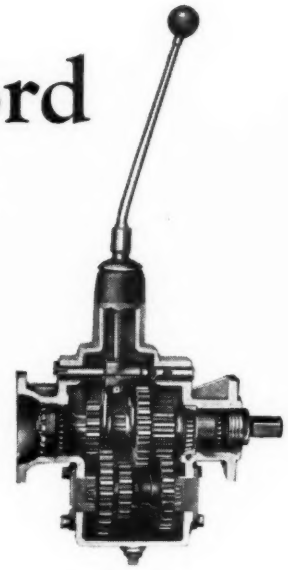

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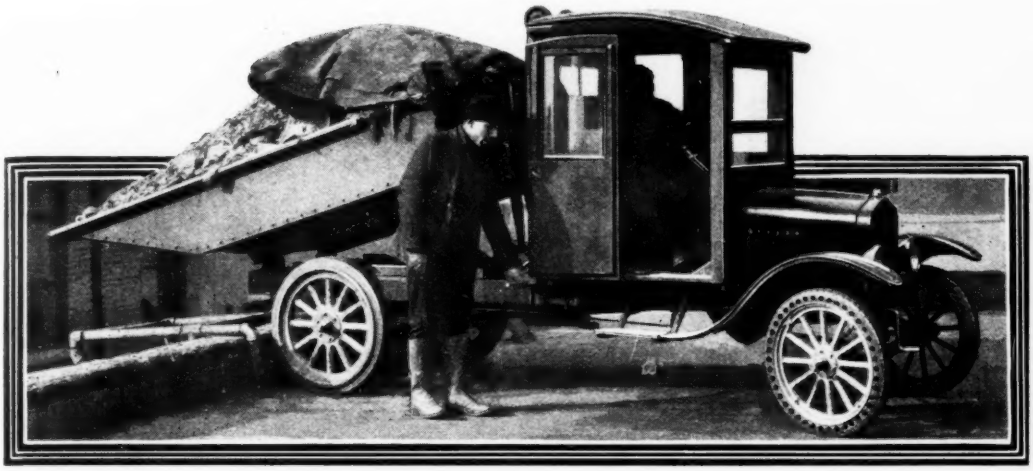

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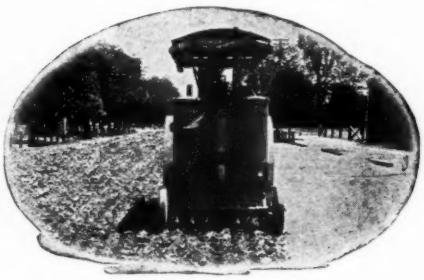

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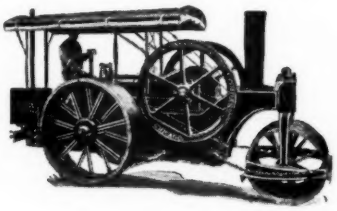

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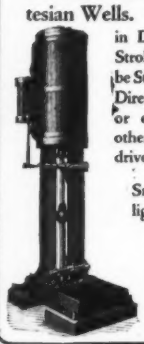

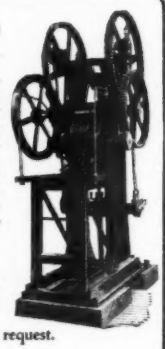

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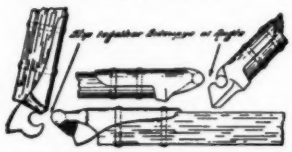

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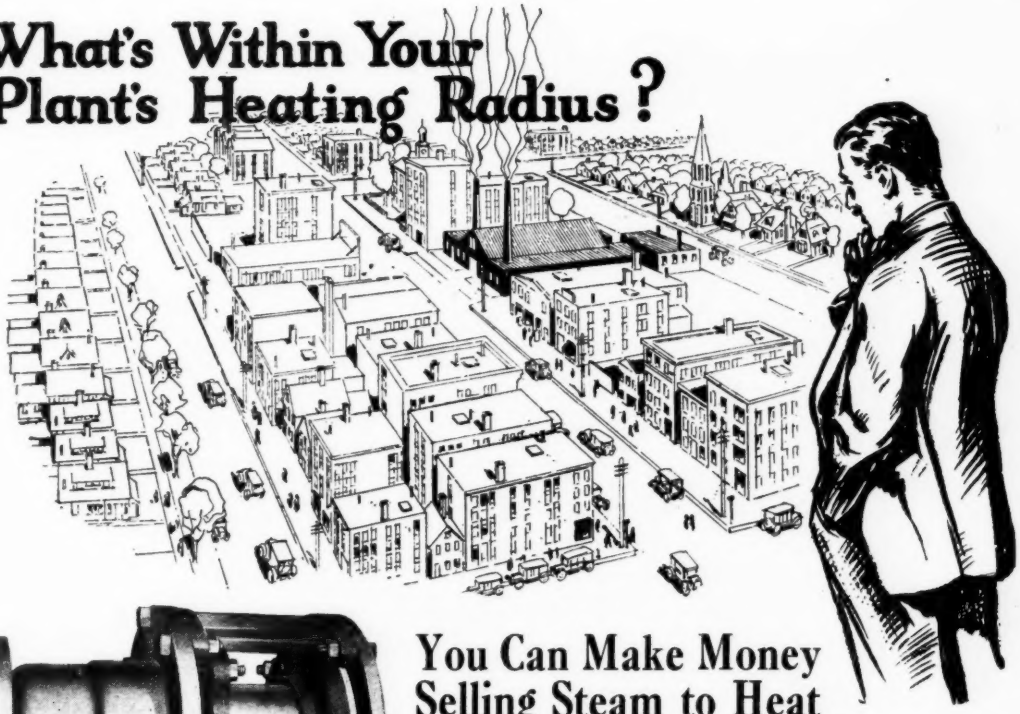

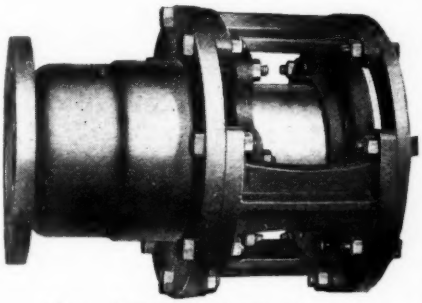

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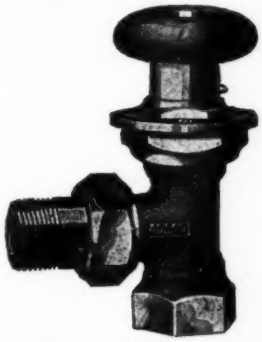

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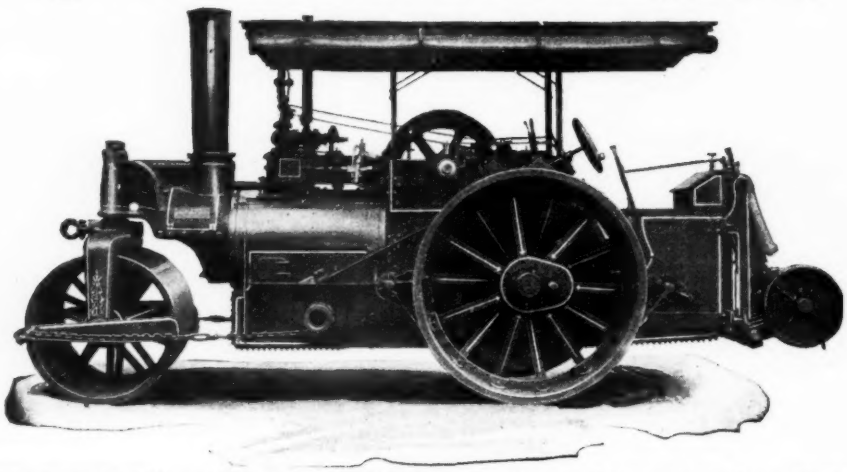

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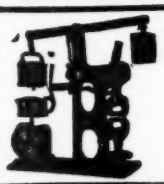

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# SEGMENT-BLOCK TILE DRAIN CONSTRUCTION

*By W. A. Olson, Drainage Engineer, Nevada, Iowa*

We have in Story County, Iowa, five different drainage districts in which segment blocks have been used for a total of 15,925 ft. of drains, varying in size from 36 to 45 in. There are 3,600 ft. of 36 in., 10,321 ft. of 39 in., 1,578 ft. of 42 in. and 426 ft. of 45 in. These drains have varied in depth from about 6 ft. to 12½ ft. The first of this type of tile drain that we laid was in the fall of 1916, and this last fall finished the construction of the fifth segment block drain.

### *Soil Conditions*

The kind of soil encountered during the construction of any tile drain affects very greatly the progress of the work, and may also make a difference in the amount of repairs of a tile line after its completion.

The first three or four drains constructed in which the segment blocks were used the soil conditions were found to be quite favorable for this type of construction, being for the most part a yellow clay, firm enough to allow the excavation for the blocks, and shaping the bottom of the trench to conform to the outside of the segment blocks without much trouble about caving. On one of the drains where 4,875 ft. of 39 in. segment blocks were used, ranging in depth from about 7½ to 12½ ft., the soil was of a heavy yellow clay (except for the surface soil and for perhaps about 150 ft. in two or three places that caved some) which even for the 12½ ft. depth stood up so well that no curbing was used (a practice, however, that I would not recommend for ditches of that depth) and the bottom of the trench was shaped to fit the outside of the blocks for the lower half of the circle by the use of a templet.

### *Laying the Blocks*

The bottom or invert blocks are first laid and next the blocks for the sides up to the spring line or horizontal center line of the tile and then by the use of a collapsible form the blocks for the top part of the drain are placed.

As the drain is completed it should be covered by hand to a depth of about 1 ft. and allowed to settle well or be tamped before more filling is done in order not to disturb the blocks and to insure the load coming upon the blocks evenly.

For deep work, especially if the ground tends to cave, more covering should be placed, say as much as 2 or 3 ft., to insure that the block tile will be protected in case of bad caving.

### *Excavating for Invert Block*

In using a templet for the excavation for the lower part of the block I prefer to have it so shaped that the horizontal diameter of the finished drain will be slightly less than the vertical diameter, from about ½ in. to 1 in., depending upon the character of the soil. This allows for a slight settlement of the blocks, while receiving the load due to the filling before they are circular, and in case the settlement does not make the drain quite a true circle would rather have the vertical diameter a trifle longer than the horizontal diameter to avoid the danger of having the blocks flatten out too much if built exactly circular in the first place.

In constructing this type of drain it is very important to have the excavation for the lower half of the drain accurately done, because if the lower part of the drain is accurately constructed and held firmly in place the upper half of the drain will take care of itself.

### *Use of Cement Mortar*

A part of our segment block drains have been constructed with the use of cement mortar for the longitudinal joints and part of them without the cement mortar. It is really not necessary to use the cement mortar for ordinary block construction, unless to seal the joints through sand or in case of deep work where the load on the tile line is great and the mortar is needed to act as a cushion between the blocks.

Shaping the bottom of the trench and constructing a segment block drain is quite a different matter, however, if the ground is sandy or caves badly. The last drain we constructed in which the segment blocks were used we had about 3,000 ft. of the 36 in. ranging in depth from 9 to 11½ ft. where for most of the way the ground caved more or less and was what the ditchers termed "slippery" clay which caused a good deal of trouble and more extra expense. Not all of the lower part of the trench for the bottom half of the block could be shaped to fit the blocks and the dirt back of the side blocks had to be thoroughly tamped to hold them in place.

### *Cost More to Lay than Solid Tile*

Bad digging conditions where sandy or cavey ground is encountered usually means extra grief for the contractor

even if solid tile are used, and if segment blocks are used there are possibilities for quite a substantial increase of grief. This must be compensated for by an increase in the price for laying the blocks, and even where the soil conditions are the most favorable it is worth more money to lay the segment blocks for tile drains than the solid tile.

*Contractors Don't Like the Segment Blocks*

It seems that as a rule contractors are inclined to shy at the prospect of laying the segment blocks, although there are a few that have laid them who seem to consider the expense of laying them as not so greatly in excess of the expense of laying the solid tile.

*Comparative Costs*

During the past eighteen months we have had bids on two different jobs by contractors that have had experience with this type of drains, that ranged as low as about 15% extra of the labor cost for solid tile and bids by other contractors that ranged as high as 100% of the labor cost, extra. From my experience with the segment block construction and for average conditions in our part of the state would estimate that the extra labor would vary from 20% to 40% over the price for solid tile, depending a great deal upon the depth of the drain and the character of the soil. However, for some soils this might be entirely too low.

*A Minimum of Repairs*

The segment block tile drains are more expensive to construct than solid tile drains, but once properly constructed, it has been my experience that there will be little or no repairing to be paid for which is quite an advantage over solid tile construction.

The foregoing paper by Mr. Olson was presented before the Drainage Section of the Iowa Engineering Society, Jan. 30, 1924.

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## A DIESEL ENGINE IN CITY SERVICE ESTABLISHES A NON-STOP RECORD OF 202 DAYS

The high efficiency of the Diesel engine is already well known, but that it is able to operate continuously, without stop, is not so well known.

Reliability is usually more important in any engine than is efficiency. To be truly economical the engine must be both efficient and capable of reliable service. The reliability of an engine whether in an aeroplane, automobile, or power plant, depends largely upon its ability to operate any desired length of time without shut-down.

Owners of engines and users of power throughout the world will therefore be interested in a continuous run of 202 days, under actual working conditions reported by the Worthington Pump and Machinery Corporation for a Worthington Snow Diesel engine.

The engine is a standard 562 h. p., four-cycle, air injection type operating at 225 r. p. m. and is used by the City of Horton, Kansas, for city lighting and power purposes, driving an alternating current generator in parallel with another unit-evidence of close governing as well as continuity of performance through the entire period. The engine has three cylinders, each 22½x22½ ins. and of the so-called square type. The pistons are oil-cooled. Lubrication is forcibly fed to all parts of the engine.

In small municipal plants loads naturally vary considerably, from heavy to light. The Snow engine met all conditions without any difficulty and satisfactorily fulfilled the guarantee made by the manufacturers.

The following interesting remarks were made by J. J. Lindsay, Commissioner of Finance of Horton:

"We are not trying to make a record run. There is no mechanical cause for a shut down. In other words. 'Day by day, in every way, she is running better and better.'

"I have suggested to Superintendent Guenther that he might reduce operation cost by locking the building and laying off the engineers. It seems a shame to have men wearing their trouser seats out just watching perpetual motion. I have yet to run into a like performance.

"I always hated to reduce the rates for light for in the past I was always up against the proposition of this department of the City being out of funds or verging on it. The rates have now been reduced materially and the engine must be given the credit. In addition to making lots of juice we are making a handsome profit out of our plant."

M. L. Rousey, Mayor of Hortlon, and G. H. Myland, Commissioner of Utilities, officially verify the record.

The old plant, before the installation of the Diesel engine, was steam operated.

# TENTATIVE CONCLUSIONS ON THE DESIGN OF CONCRETE HIGHWAYS

*By Clifford Older, of Consocr, Older & Quinlan, Consulting Engineers, 1739 Marquette Bldg., Chicago. Formerly Chief Engineer, Illinois Division of Highways*

(Editor's Note: The following paper by Mr. Older was presented at the meeting of the American Association of State Highway Officials at New Orleans in December, 1923. It relates to the developments of the past year in Illinois highway research work, and their probable bearing upon the problem of rural pavement design.)

*Impact Effect of Truck Wheel Loads*

In considering the design of a pavement, it is necessary either to assume the maximum expected wheel load or be governed by the limits set by law. As highway traffic imposes moving loads, the impact effect of such loads should be understood.

The impact effect of wheel loads on concrete pavements, and pavements having concrete bases only, was investgated. As at the time this work was under way, no suitable instrument could be found for measuring the fibre deformation in the upper face of a concrete slab during the passage of moving loads, an attempt was made to find a measure of impact stresses by means of accurate observations of deflections. Records of rigid pavement failures seem to indicate that in pavements of ordinary design, maximum stresses occur at corners and unbroken edges. Impact observations were accordingly confined to such points.

It was thought possible that a sudden blow, such as that produced by the falling of a truck wheel from an obstruction, might result in a deflection curve of shorter radius than that produced by a static load necessary to give the same total deflection at a given point. In order to establish the relationship of deflection curves produced by impact and static loads, the following scheme was finally devised; At intervals along the edge of the pavement slab under investigation, Ames dials were so located as to indicate the deflection of the slab at distances of 0 ins., 20 ins., 4 ft., 7 ft., 10 ft., 13 ft., and 16 ft. from the point of observation. The dials were actuated by means of metallic lugs attached to the pavement edge. They were also equipped with a friction device, by means of which the spindle and the index pointer would move to the point of maximum deflection and retain that position after the load was removed and the pavement slab had recovered its original elevation. A small light bulb at each dial was so connected by wires carrying electric current that contact between the lug and dial would cause the bulb to light.

The procedure was then as follows: The spindle of each dial was adjusted to contact with the lug, each bulb therefore being lighted. A wheel of a loaded truck was then lifted by means of a hy-

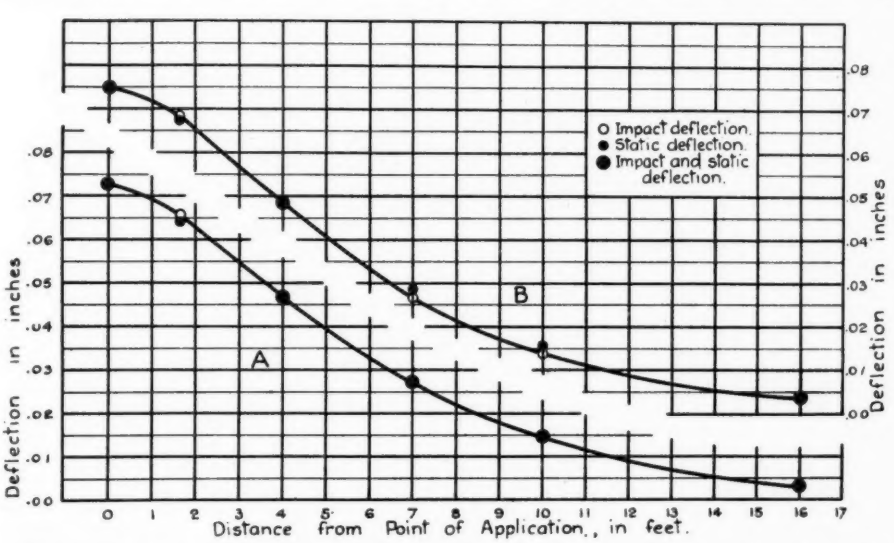


FIG. 1—STATIC AND IMPACT DEFLECTION CURVES, NIGHT RUN, AUG. 30, 1922.

draulic jack and allowed to fall upon the pavement edge or corner at a point immediately opposite the zero dial. The wheel load and height of drop were varied to represent impact conditions up to such extremes as the slab might be expected to resist without failure.

Results were recorded of only such loads and drops as caused an impact deflection greater than that resulting from the load at rest. The fact that the dropping of the wheel extinguished all of the lights, with no subsequent flicker, indicated conclusively that the dials recorded the impact deflection only, rather than any subsequent vibratory or static load deflection. Following the drop of the wheel, the dials were read and by means of a hydraulic jack and a loadometer, a gradually increasing load was applied at the same point on the pavement. The load was increased until contact was secured at the zero dial. The dials not then showing lighted bulbs were adjusted to contact and all dials read. The first set of readings, then, defined the impact deflection curve, and the second a static deflection curve having an equal maximum.

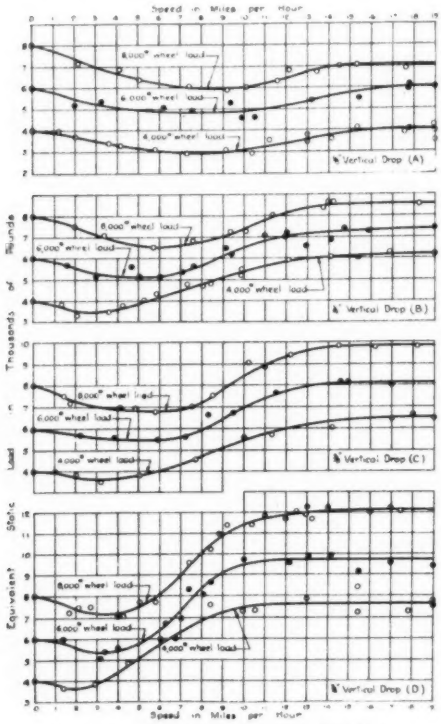


FIG. 2—IMPACT DEFLECTION CURVES.

Figure 1—A shows the result of one of a number of night tests in which the impact and static deflection curves coincide almost perfectly.

In Figure 1-B is plotted the readings of the night test that resulted in the greatest variance between the impact and static deflection curves. The average results of the night tests show a very close coincidence of impact and static curves. The close conformity of these curves may be appreciated when it is known that although a 10,000-lb. static load might be necessary to effect a pavement deflection sufficient to light the first bulb, yet an increase of only about 200 lbs. would cause contact at all of the remaining dials. In many cases several of the bulbs would light at the same instant. Often when the first bulb showed contact, a man jumping on the edge of the pavement could make or break contact at all of the dials.

Tests conducted during daylight hours were less reliable, owing doubtless to temperature effects. All such tests were therefore conducted at night during periods of least subgrade support resulting from temperature warping of the slabs. The warping of pavement slabs due to changes of temperature has previously been discussed.

*Deflection Method of Measuring Impact*

The close coincidence of the impact and static deflection curves seems to indicate that the deflection method is reasonably reliable. A description of the deflection method adopted for determining actual impact follows:

A smooth runway consisting of steel plates was laid on the surface of the pavement. A loaded truck was placed on the shoulder and arranged in such a manner that a hydraulic jack, reacting against an I-beam which could be quickly run out from under the truck body, could be used to impose a static load of any required amount at the point where one wheel of a moving truck would fall from the end of the runway. An Ames dial with a friction device, arranged to indicate maximum deflection, was placed at the edge of the pavement opposite the point where the wheel would strike. An electric contact and light bulb was so arranged that a subsequent equal deflection would light the bulb. Electric contact points at fixed distances on the runway, and a stop watch afforded means for determining the speed of the truck. The truck was then driven along the runway and immediately after it had passed, the hydraulic jack together with a weigh-

ing device was swung out and a static load of increasing amount applied until contact was secured at the dial.

Assuming that the impact and static deflection curves are coincident in all directions and assuming also that if the radius of deflection curvature is the same, the fibre deformations and stresses are equal also, then the ratio of the static load to the moving wheel load should represent the correct impact factor to allow for the conditions used in the test.

Following a series of runs designed to determine relationship between impact and static loads resulting in equal deflections for various speeds and height of drop, the truck was operated in the opposite direction so that the impact would be that caused by the wheel mounting the obstruction.

Figures 2-A, 2-B, 2-C and 2-D show the results obtained for wheel loads of 4,000 lbs., 6,000 lbs. and 8,000 lbs. for drops of ⅛ in., ¼ in., ⅜ in. and ¾ in. and for truck speeds varying from about 1 mile per hour to about 20 miles per hour. The unsprung weight was constant.

Figures 3-A, 3-B, 3-C and 3-D show the results obtained for the same wheel loads and speed range, with the truck operating in the opposite direction so as to mount the obstruction.

These results indicate that for all heights of drop or obstruction used, the deflection at the critical point caused by the moving load decreased as the speed increased to a certain point; then increased more or less gradually as the speed increased. The wheel loads were increased by placing weights in the body of the truck and therefore above the springs. Note that the addition of load above the springs distinctly lowered the minimum value of equivalent static load for all heights of drop and to a lesser degree for the ⅛ in. and ¼ in. elevations. The difference between the minimum and maximum equivalent static load was not greatly affected by a change in load above the springs. For all heights of drop, this results in a lowering of the impact factor (ratio of equivalent static load to wheel load) as the load above the springs is increased.

For the ⅛ in. drop and ⅛ in. obstruction with the truck fully loaded and at all speeds, the equivalent static load was less than the static load of the moving wheel. For ¼ in. drops (truck fully loaded) the equivalent static load was less than the truck wheel load until the speed exceeded about 12 miles per hour, and did not increase materially for speeds in excess of 14 miles per hour. The maximum equivalent static load for the 8,000 lb. wheel load was but little greater than the wheel load itself.

In mounting the ¼ in. obstruction the critical speed was about 10 miles per hour and the equivalent static load did not increase materially for speeds in excess of 14 miles per hour. For the greater drops and elevations, the critical point was passed at lower speeds and the maximum impact effect was much greater.

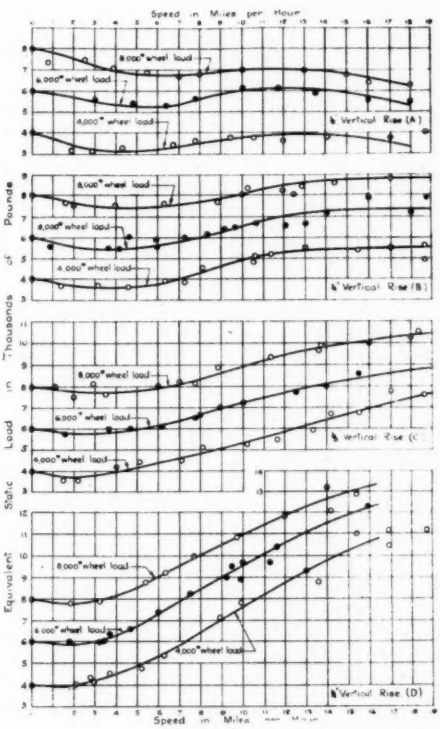


FIG. 3—IMPACT DEFLECTION CURVES.

The value of Figs 2 and 3 as an index of the relative magnitude of impact and static load stresses is dependent upon the equality of the shortest radius of the impact and static load deflection curves. The degree of coincidence shown by Fig 1 seems to indicate that these results should not be greatly in error.

Practically all modern rigid pavement specifications provide for a variation from the true surface not to exceed ¼ in. As such variations are rarely abrupt,

it would seem the impact factor is not of sufficient importance to justify any great allowance in design. In pavement construction at the present time, it is not unduly burdensome to secure a surface complying with the ¼ in. requirement. Accidental obstructions, such as might be afforded by loose boards or a heaved pavement slab, do not occur at sufficient intervals to justify an allowance in design for such obstructions.

*Subgrade Soil Investigations*

Further studies have been made relating to the behavior of subgrade soils under load. Research along this line by the Illinois Highway Department has so far been largely confined to what might generally be classed as clay soils.

It has been fairly well established that the bearing value of a clay soil varies

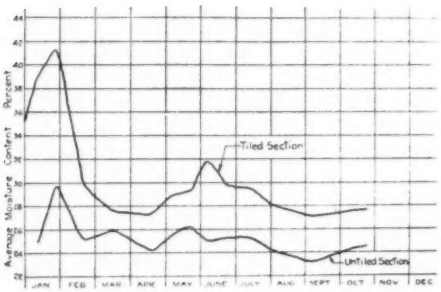


FIG. 4—MOISTURE CONTENT CURVES OF CHATHAM ROAD.

with its moisture content. Attempts made to control the moisture content of the subgrade soil are therefore of interest.

*Tile Drainage*

Observations made during the past year relating to attempted control of moisture content by means of tile drainage seem to confirm previous research along this line. It is perhaps worth while to bring this matter up to date.

When the Bates Road was originally constructed, under each edge of a 200 ft. section was laid a tile drain 24 ins. below the elevation of subgrade, the trench back-filled with cinders, and a free outlet provided for the tile. Moisture samples were taken from underneath the slab at various points throughout this 200 ft. section, and at various points from underneath the adjacent undrained slabs. For a period of three years no measurable difference in the moisture content of the subgrade at these points has been observed. At another point on a public highway, called "Chatham Road," where clay of a different character is encountered, tile drains were laid 42 ins. under each edge of the pavement for a distance of 1000 ft. and the trenches back-filled with cinders. Moisture samples were then taken periodically from underneath this slab and from underneath adjacent slabs laid on the same character of soil. Fig 4 shows the result of these observations. No attempt is made to explain the reason why the soil underneath the section provided with tile drains has throughout the entire period contained more moisture than that under the adjacent pavement. It would seem that the tile drains in each of these cases were of absolutely no value in reducing the moisture content of the subgrade, and that this method of attempting the control of subgrade moisture in clay soils is of extremely doubtful value.

*Moisture Absorption of Subgrade Soil as Affected by Its Moisture Content*

It was found that both the brown silt loam of the Bates Road subgrade and the yellow clay of the "Chatham Road," when containing a moisture content which may be considered normal for the summer months, resist further saturation to a marked degree. Attempts to saturate the subgrade soil underneath the Bates Road failed. Water standing at subgrade elevation for six weeks during the summer months did not cause a perceptible rise in the moisture content of the subgrade soil at a sampling station 30 ins. distant. Tests now under way on 30 samples of clay soils, gathered from different points throughout the State, indicate that this phenomenon in slightly varying degree is probably common to all.

Another series of experiments indicate that if the moisture content of any of these clay soils in reduced to a point where the soil is dry enough to pulverize, the soil then absorbs water rapidly and becomes highly saturated within a very short time.

These two properties of clay soils may have a marked effect upon the supporting power of the subgrade under a freshly laid pavement slab. For example: The sections of the Bates Road built in the fall of 1920 were laid on a sun-dried subgrade, as a rainless period and hot weather had preceded the construction of the pavement. In October, 1920, the first moisture samples were taken from underneath the road just after a three day period of rain. At that time the

subgrade soil was found to be as nearly saturated as at any other time. On the other hand, sections 64 to 68 inclusive were laid in the fall of 1922, when the subgrade soil contained about 25% moisture. The moisture content of the soil under these slabs remained practically constant throughout the winter months of 1922-23 and, although the spring and summer rains were heavy and frequent, it continued throughout the summer of 1923 materially below that of the remainder of the road.

From this it may be inferred that for perhaps a period of a year or more after a pavement is laid, the bearing power of a clay subgrade soil may be materially affected by its moisture content at the time of construction.

*Subgrade Bearing Tests*

Many attempts have been made to evaluate the bearing power of the subgrade soil of the Bates Road, as well as that of other Illinois soils. As narrow rural pavements encourage the passage of highway loads along fairly definite paths, it was thought necessary to determine the relationship between the bearing power of subgrade soils and repeated loads. An apparatus was devised by means of which repeated loads on areas of a few square inches could be made with facility. The use of this apparatus immediately called attention to the excessive depression or permanent deformation caused by the first few applications of load. After several hundred applications of load on small areas, the soils in some cases seemed to become more or less stabilized, and show decided elastic properties.

Believing that the initial excessive depression might be due to a poor contact between the metal shoe, used for imposing pressures, and the soil, and might also be the small area under pressure, a number of concrete slabs 3 ft. in diameter were cast on the subgrade adjacent to the edge of the Bates Road pavement. It was thought these slabs would have an initial bearing on the subgrade soil, at least as satisfactory as that of existing pavements. Repeated loads were applied to these slabs. Owing to the cumbersome arrangement of the apparatus used for applying loads, it was not practicable to make large numbers of repetitions during periods while conditions affecting subgrade support remained constant. Fig 5 shows the results of a series of tests on Slab No. 3. This series of tests included 10 applications of a load of 6 lbs. per sq. in. repeated six times with intervening rest periods of 24 hours each. The upper points of the curve show the unloaded elevation of the slab referred to, the zero reference being the elevation at the beginning of the series of tests. The lower points indicate the position under load. The loads were applied in each case at 15 minute intervals. The moisture content of the subgrade (26.8%) may be considered normal for this soil during the early fall months. This series of tests were started on Oct. 3, 1921. The principal points of interest are: The permanent depression due to the first load applied after each period of rest; recovery of elevation during the rest periods; resultant depression at the end of the third day; decreased permanent depressions on succeeding days.

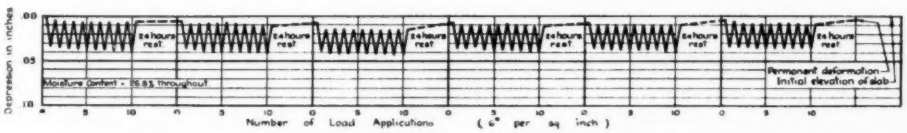


FIG. 5—SOIL DEFORMATION RESULTING FROM REPEATED BEARING LOADS, SLAB 3, SEPT. 28, 1921 TO OCT. 3, 1921.

Fig 6 shows the effect of a series of repetitions of a load of 6 lbs. per square inch on Slab No. 1 on Nov. 30, Dec. 1 and Dec. 6, 1921, and Feb. 20 and March 8, 1922. Between Dec. 6 and Feb. 20 the ground had frozen and thawed a number of times and the moisture content of the subgrade soil had increased from 28% to 33.8%. On March 8 the moisture content had decreased to 28.8%. The excessive permanent depression recorded on Feb. 20 may be accounted for partly by the increased moisture content, but probably was chiefly due to freezing and thawing of the soil. This may be inferred from the fact that excessive depressions were also recorded on March 8, at which time the moisture content was practically the same as on Dec. 1. However, the soil had been frozen and thawed once or twice between Feb. 20 and March 8. All of the other slabs used for similar observations behaved in the same man-

ner, but in varying degree. Tests of the same nature are now being made on 30 different types of Illinois subgrade soils by means of an apparatus that will allow the application of large numbers of repeated loads at short intervals on areas of approximately 7 sq. ft. The results of these tests are not sufficiently complete to justify definite conclusions.

Present indications point to the probability that none of the clay soils so far investigated exhibit sufficiently uniform elastic properties to justify an assumption of elastic subgrade supporting power in a design formula. It is certain that for purposes of pavement design, reliance may not safely be placed upon a bearing power test involving only a single application of load.

A consideration of the behavior of the soils tested under repeated loads indicates that bearing pressures no greater than those which obtain under ordinary pavement slabs may at certain times cause more or less rutting of the subgrade. The marked permanent depression which occurs, following a freezing and thawing of the soil, greatly increases this effect and no doubt at such times results in strips of the pavement slab becoming practically unsupported by the subgrade.

This fact, together with a consideration of the warping of rigid pavement slabs, confirms the belief that the edges at least of such pavement slabs should be designed as unsupported cantilevers.

*New Test Sections with Thickened Edges*

The above considerations led to the construction, in the fall of 1923, of four additional test sections. The edge thickness of these sections was designed by the formula $D=\sqrt{\frac{3W}{S}}$ the derivation of which was described in a previous paper. In this formula W was made equal to the legal wheel load limit of Illinois, i. e. 8000 lbs., and S one-half of the expected modulus of rupture of the concrete used (300). These sections were numbered 65, 66, 67 and 68. In accordance with the formula, the edge thickness of all sections was made 9 ins. The length of each section was about 350 ft. Section 65 was 18 ft. wide and the edge thickness tapered to 6 in. two feet from the edge. Section 66 was 20 ft. wide, otherwise the same as Section 65. Section 67 was also 20 ft. wide, the edge thickness tapering to 5 ins. two feet from the edge. Section 68 was 18 ft. wide, the edge thickness tapering to 4½ ins. two feet from the edge. A variation of the mid-portion thickness was made to throw light on a proper balance between the mid-portion and edge thickness. The 20 ft. width sections were included in order that the effect of width on load carrying capacity might be illustrated.

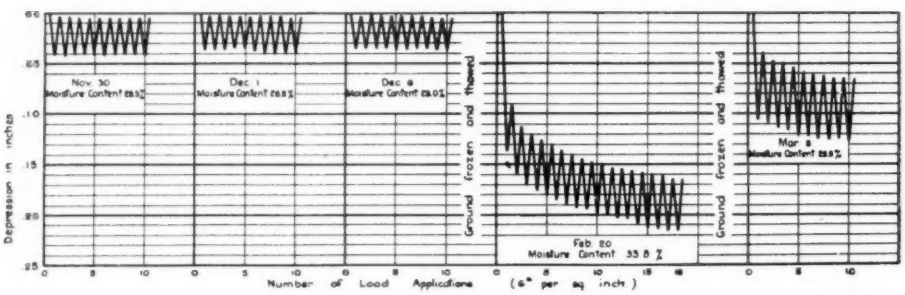


FIG. 6—SOIL DEFORMATION RESULTING FROM REPEATED BEARING LOADS, SHOWING EFFECT OF FREEZING AND THAWING, SLAB 1, NOV. 30, 1921 TO MARCH 8, 1922.

In the spring of 1923 these sections, together with certain of the original sections, were subjected to artificial truck traffic. On sections 65 to 68 inclusive the truck traffic started with wheel loads of 6500 lbs.

The second increment was inadvertently made 8750 lbs. instead of 8000 lbs. as intended because of the fact that the weighing device used was out of order. The third increment was then made 8000 lbs., and the fourth, fifth, sixth and seventh increments, 10,000 lbs., 11,000 lbs. 12,000 lbs. and 13,000 lbs. respectively. The trucks made 3,000 round trips with each increment excepting the third (8,000 lb. wheel load). Ten thousand round trips were made with the third increment.

The only observable effect of this traffic on Section 65 was the formation of two short longitudinal cracks in the half

of the pavement south of the longitudinal joint, and the formation of three transverse cracks, also in the south half of the pavement only.

Inasmuch as this section sustained wheel loads up to 62 per cent in excess of the Illinois legal limit, it may safely be concluded that its design provided an ample factor of safety for the Illinois legal wheel load limit of 8,000 lbs.

In Sections 66 two very short longitudinal cracks appeared at each end of the section, and in the south half of the pavement. Two transverse cracks also occurred in the south half of the pavement. No damage of any kind was noted in the north half. This design, which was subjected to the same traffic, may also be assumed as providing an equal or greater factor of safety.

In Section 67 three transverse cracks appeared in the north half of the pavement, four in the south half, and one short longitudinal crack started in the south half near one end. As, at the conclusion of traffic runs, no damage had appeared which would impair the serviceability or increase the maintenance cost, this section also may be considered to have a reasonable factor of safety for the wheel loads assumed.

Sections 68, shown in Fig 7, is worthy of special note. Transverse cracks appeared early in the test run. At "B" appeared short transverse cracks near a construction joint. At this place cracks approximately parallel to the edge soon appeared, joining the transverse cracks. At "A" and also at "D" a number of transverse cracks formed, beginning at the south edge and running part way toward the center. Throughout the traffic test, however, the transverse cracks at "A" did not result in complete destruction of this area. At "B" complete destruction of the edge eventually occured, which later resulted in the destruction of a considerable area of the mid-portion of the slab. At points marked "C" breakage started in the mid-portion of the slab, and developed to a marked extent. The character of the damage occurring at points "B" and "C" seems to indicate that the resistance to structural failure of this section was about the same along the edge as throughout the mid-portion. No doubt the longitudinal edge bar aided materially in preventing earlier destruction along the edges at A. B and D.

It should be noted that while the effective depth of the extreme edge of each of these sections was 9 ins. at two feet from the edge, the thickness varied from 4½-to 6 ins. The edge strength therefore of Section 68 was materially less than that of Section 65.

It is unfortunate that a large number of sections, designed to develop more

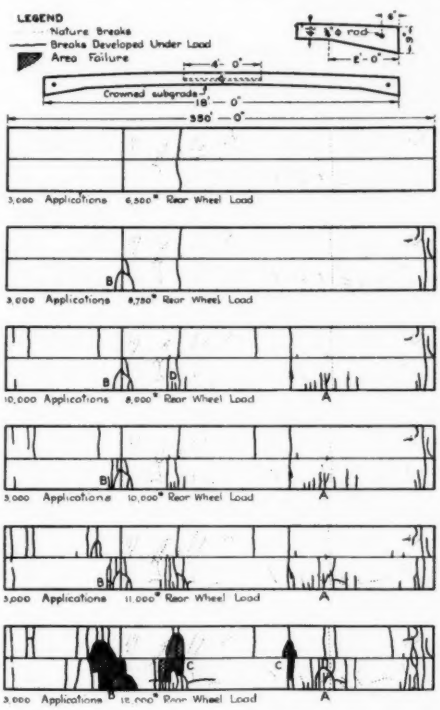
LEGEND
Nature Breaks
Breaks Developed Under Load
Area Failure
Crowned subgrade
3,000 Applications 6,500# Rear Wheel Load
3,000 Applications 8,750# Rear Wheel Load
10,000 Applications 8,000# Rear Wheel Load
3,000 Applications 10,000# Rear Wheel Load
3,000 Applications 11,000# Rear Wheel Load
3,000 Applications 12,000# Rear Wheel Load

FIG. 7—TRAFFIC EFFECTS, SEC. 68, 9-IN. EDGE, 4½-IN. CENTER.

completely a proper edge design and balance of edge and mid-portion strength, were not constructed.

It is interesting to contrast the behavior of Sections 65 to 68 inclusive with that of Section 54 which was subjected only to maximum wheel loads of 8,000 lbs. Fig 8 shows the behavior of Section 54 which is typical of that of all sections not having effective provisions for increasing edge strength. At the end of 3,000 round trips of the 5500 lb. wheel load, distinct corner breaks appeared at "A". Substituting the thickness of this section (5 ins.) for D in the formula

$$D = \sqrt{\frac{3W}{S}}$$

and substituting also 5500 for W and solving for S the fibre stresses when this corner broke would figures 660 lbs. per square inch. These corners pulverized under the 6500 lb. wheel load and

progressive destruction from these corner breaks rapidly led to the destruction of the section under the 8000 ft. wheel load.

*Notes on Rigid Pavement Design*

No mention has been made heretofore of the fact that the outer truck wheels on the north half of the pavement, traveling at a uniform distance of 35 ins. from the edge of the slab, caused practically no damage to any of the test sections, and although the inner wheels of this line of traffic traveled immediately adjacent to the center joint where such joint was provided, no direct damage resulted excepting to Section 68.

In rigid sections (with the exception of Section 68) where eventually the entire width was finally destroyed, the damage

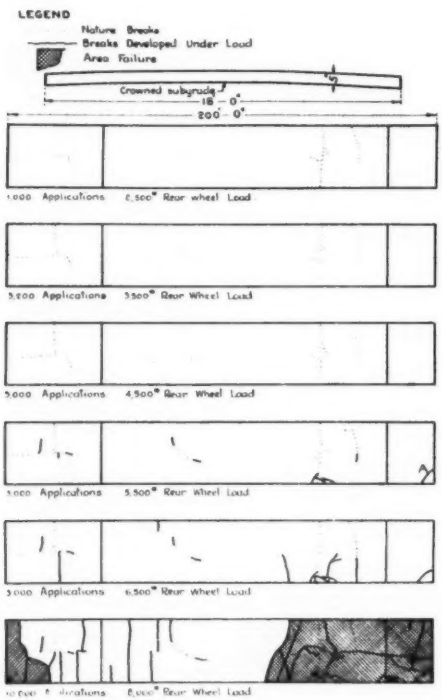


FIG. 8.—TRAFFIC EFFECTS, SEC. 54, 5-IN. UNIFORM-LIMESTONE USED.

always started at the south edge of the pavement and progressed across the slab. This fact indicates in a striking manner that if unsupported edges can be avoided or if such edges are properly strengthened, the mid-portion of paving slabs may safely be built thinner than has heretofore been considered necessary.

It is believed that local subgrade settlements, irregularities of subgrade supporting power, or other local subgrade weaknesses, are always likely to exist at sufficiently frequent intervals to permit the formation of transverse cracks unless transverse joints are spaced at much more frequent intervals than heretofore considered necessary. If this be true, it would appear that exposed edges of all pavement slabs should be thickened, or otherwise continuously strengthened, so that the occurrence of transverse cracks may not result in weak corners.

As many clay soils when dry readily take up sufficient moisture to cause a high degree of saturation, but absorb water very slowly when moist, it is believed that dry clay subgrades should be moistened to a considerable depth by sprinkling before a pavement is laid. If the pavement is laid on a dry clay soil, excessive saturation and minimum bearing values may occur before the concrete has attained normal strength.

A longitudinal tongue and groove doweled center joint in an 18 ft. pavement is apparently effective in preventing longitudinal cracks as well as in reducing temperature warping. During the past three years, about 1500 miles of Illinois rural pavement have been built with this type of center joint, and no longitudinal cracks have appeared to date. The corners formed at the intersection of transverse joints and cracks with the center joint have not appeared to be points of weakness in service pavements, nor did they appear so in the Bates Road. This is no doubt due chiefly to the effectiveness of the tongue and groove joint in transmitting by sheer one-half of the loads to the adjacent slab.

Self-supporting edge corners may be insured by proportioning the thickness of slab edges by the formula previously given. In this formula the value of S should not be greater than one-half of the modulus of rupture of the concrete used, in order to avoid failure by fatigue. It is suggested that this thickness should be maintained for a distance of about two feet from the edge and then decreased in another two feet to the mid-portion thickness. This is suggested inasmuch as initial corner breaks normally extend not more than two feet from the edge of the pavement.

Continuous longitudinal sheer bars along the edges of concrete slabs aid materially in effecting a mutual support of the adjacent edge corners for a more

or less prolonged period, depending upon the volume of traffic and in addition are of marked advantage in preventing rapid progressive destruction in case corner breaks occur.

Any design in which reinforcing steel is expected to relieve the concrete of all tensile stresses should take into account the possibility of the appearance of corners at any point along the edge of the slab.

If a doweled tongue and groove longitudinal joint is used, the strength of slab adjacent thereto need be but one-half that at the outer edge, inasmuch as two edges or interior corners would, in such cases, always be available to support the wheel loads. The thickness along the center joint might well, therefore, be proportioned by the formula $D=\sqrt{\frac{1\frac{1}{2}W}{S}}$

Section 68, apparently, showed a fairly even balance of traffic supporting capacity along the outer edge and along the center joint, although the thickness adjacent to the center joint was less than required by the above formula.

*Thickness of Mid-Portion of Slab*

No very definite conclusions may be drawn as to the necessary thickness of the mid-portion of the slab. It is suggested that inasmuch as deflection measurements indicate that the deflection of the mid-portion of slabs of uniform thickness is about one-third of that at the edge, the mid-portion thickness might tentatively be made such that the transverse strength figured as a beam be one-third that of the edge. A mid-portion thickness determined by the formula $D=\sqrt{\frac{W}{S}}$ would fulfill this condition.

It is certain that if the three formulas proposed be solved for safe load (using for S ½ of the modulus of rupture of the concrete) no rigid sections of the Bates Road failed structurally under such load.

In view of the vast expenditures usually being made for paved roads, the lack of more complete scientific knowledge of pavement design should be relieved as soon as possible by a continuation of intense research activity.

# ELECTRIC LIGHT AND WATER UTILITIES FOR FRENCH LICK AND WEST BADEN, INDIANA

*By Charles Brossman, Consulting Engineer, Merchants Bank Bldg., Indianapolis, Ind.*

The water supply for French Lick and West Baden is taken from Lost River, which is a stream of interest due to its disappearing and traveling underground in the cavernous limestone region and reappearing at intervals along its route. This stream is not large, but is subject to great fluctuations of flow and characteristics of its water. In a few hours it will change from a clear to an exceedingly turbid stream with a very high percentage of sediment—in the form of very fine clays. The stream is, of course, subject to surface flow and the pollution that is characteristic of such waters.

In the towns of French Lick and West Baden are the two large, nationally-known, hotels which are famous for their medicinal waters and baths. Well waters for domestic supply are not easily obtainable. One well where a fairly good water was procured was drilled several years ago but as it affected the mineral springs, after litigation it was sealed. Lost River was the remaining source of supply, which is now used by the water company. The hotel at French Lick procures its supply from a small creek known as French Lick Creek, but the flow of this becomes exceedingly low in the dry season. The West Baden Springs Hotel pumps from Lost River about 200 ft. below the utility intake. To some extent the town and hotels have been somewhat inter-dependent on each other.

*Present Water Plant*

Lost River has always given a large enough supply but the utility plant has been unable to supply all the demands made upon it, due to its limited capacity. The present water works plant for the two towns consists of two pressure filters, 8 ft. diameter by 12 ft. long, with a capacity of 250,000 gals. each per 24 hours. This water is pumped directly through the filters without any preliminary sedimentation and usually the filters have been heavily overloaded and require a great percentage of wash water due to volume of material in suspension.

The present pumping equipment consists of one triplex motor-driven pump operating against a total head of about 285 ft.; this is driven by a three-phase,

220-volt motor, receiving power from the utility plant. The present utility plant is a 220-volt direct current system and for the water works service a motor generator set is used, supplying three-phase, 2,300-volt current which is again reduced to 220-volt at the pumping plant. This entails large electrical losses from the plant to the electric-driven pump.

*Water Works Plant*

In designing the new water works plant different schemes were considered: First, pressure filters; also an alternate on pumping from the river direct to the hill reservoir, and then filtration by gravity. However, the inacessible location of the reservoir would make it hard to get to and would also put the filtration plant and the pumping plant at different points, whereas it would be much more desirable to keep them together. It was finally planned to put the filtration plant at the river adjacent to the present pump house, using gravity filtration. The water will now be pumped through from the river with a low-lift pump into the settling-basin and then flow through the filters into a clear water reservoir and from there be pumped to the storage reservoir on the hill. This allows operating the pumps during the low peak periods of the power plant and will be conducive to economical operation. The main difficulty in this scheme was keeping everything above flood waters. The work as now planned will take care of this so that the filter plant will be properly protected.

*Work Contemplated*

The work contemplated at present consists of the following units and for which most of the contracts have already been let:

A sedimentation basin 50x200x10 ft. deep.

Four filter cells each 13 ft. 4 ins. by 18 ft., three of which will be installed at the present time, with a capacity of 2,000,000 gals. per 24 hours based on a rate of 2 gals. per sq. ft. The fourth filter unit will be constructed complete as far as concrete work is concerned, except that the filter itself will not be installed. This will allow for future growth and same can then be readily placed at any time it is desired.

*Water Consumption*

It is interesting to note the amount of water used by the entire Lost River valley as the hotel conditions are somewhat unusual. Water at present is being supplied through three different plants: The towns of French Lick and West Baden are supplied by the water company; the West Baden Springs Hotel has its own plant taking water from Lost River, and the French Lick Springs Hotel has its own plant taking water from Lick Creek. The approximate total amounts of water pumped in the entire valley are as follows:

| | Gallons |
|---|---|
| Towns of French Lick and West Baden | 300,000 |
| West Baden Springs Hotel | 250,000 |
| French Lick Springs Hotel | 400,000 |
| TOTAL | 950,000 |

Arrangements have been made so that as soon as the plant is put in operation the supply of the two towns and the West Baden Springs Hotel will be put on at once, amounting to approximately 600,000 gals.

*The Reservoir Problem*

An additional problem is the three reservoirs, each at different elevations. The reservoir of the water company requires about 260 ft. total head when pumping; the reservoir of the West Baden Springs Hotel is about 40 ft. lower than the water company's and the reservoir of the French Lick Springs Hotel is about 40 ft. higher than the water company's reservoir. So that in order to take care of this properly the reservoir of the West Baden Springs Hotel will have a float valve which will automatically close off as soon as the reservoir is filled so as to take care of the excess head. There will also be a separate connection so that water can be pumped direct from the pumping station to the West Baden Springs Hotel reservoir, which will probably be the usual way of pumpage as this will save the additional 40 ft. head.

When it becomes necessary to supply the French Lick Springs Hotel this can be done through a connection direct from the water company's mains and a booster pump to take care of the excess head. In this manner no excess loads will be on the pumping plant at Lost River and no water will be pumped at a double head.

*Settling Basin*

A question of great importance with this water which varies so much in turbidity, is the matter of sedimentation and the settling basin has been made amply large. The settling basin is approximately 200 ft. long, 50 ft. wide and 10 ft. deep, giving a capacity of approximately 750,000 gals. This reservoir is divided by central baffle wall which makes the actual width of the flow section 25 ft. wide. Care must be taken in

this case that when first operating under the minimum loads that too long a travel be avoided so that the floc will not be lost before reaching the filters. It is contemplated, if necessary, to take care of this by by-passing through the baffle so that later when the full capacity of the plant is reached the full capacity of the settling basin will then be utilized to advantage.

The clear well at the filter plant is approximately 234 ft. long, 30 ft. wide and 8 ft. deep with an extension under the filter house of 60x21x8 ft. deep. This gives a total capacity of 480,000 gals. in the clear well.

In addition to this, the present reservoir on the hill holds approximately 500,000 gals. so with this arrangement the electric pumps can be operated to the best advantage on the off-peak load and run the power house at best economy. In other words, the raw water pumps can be operated at light load and fill the clear water reservoir through the filters, or they can be shut down and the main pump operated pumping filtered water to the hill, or they can both be operated at the same time. This gives a very flexible arrangement and it is very important that this be done so that the power house loads can be controlled as much as possible.

*Pumping Equipment*

The present pumping equipment at the water works consists of:

One Deane Holyoke triplex pump electrically driven, capacity 350 gals. per minute.

Last fall there was installed a Midwest centrifugal pump good for a total head of 285 ft., 800 gals. per minute operated by 75 H. P. motor and on the opposite end of the pump is placed a 100 H. P. Sterling gasoline engine.

The contract has been let for an additional pump of about 450 gals. per minute motor-driven at 285 ft. head.

This gives a double equipment of one large pump at 800 gals. per minute and two smaller pumps, one at 350 gals. per minute, and one at 450 gals. per minute, so that practically any combination can be secured for pumping and water load, and still leave a reserve unit with gasoline engine drive in case the power is ever out.

*Reliability of Gasoline Drive*

On the question of reliability of the gasoline drive, it may be of interest to know what has been done in this plant. Last year when the old power plant was crippled, the new centrifugal pump, gasoline engine and motor were installed, the Company sending a truck to the factory at Anderson, Indiana, to haul the pump overland to get it in service quickly. New suction and discharge connections were shipped by express and the entire work was completed in less than a week's time. The pump, of course, had been ordered previously. This gasoline unit was put in service shortly after Thanksgiving and has operated continuously ever since from six to twelve hours a day, so that the entire water supply has been dependent on this one gasoline engine unit. The load of the West Baden Springs Hotel was taken on about a month ago and the plant has also handled this. This is about a three month's run that this gasoline engine has taken care of without the least trouble and in a very satisfactory manner and we believe this has been done at a saving over the old coal-operated plant due to the fact that the old coal-operated plants at the two stations were not very efficient.

*New Centrifugal Pumps*

The new centrifugal pumps have a guaranteed efficiency of 74 per cent so that very good results should be secured under the conditions of operation at this plant. It might be of interest to note that originally we considered triplex pumps, but the triplex pumps at 800 gals. per minute, and with auxiliary gasoline drive, were so large and so expensive that we did not feel justified in purchasing same. The efficiency was, of course, a little better, but the costs were a great deal higher and the space requirements were also greater.

*Chemical Feed*

The chemical feed consists of two dry feed chemical machines for feeding with pulverized sulphate of alumina or pulverized sulphate of iron or hydrated lime. These machines are adjustable and continuous feed type and will feed at a uniform rate of from 50 to 5,000 lbs. per 24 hours. These machines are so arranged that they can be instantly adjusted from minimum to maximum capacity while the machine is in operation giving a steady and continuous discharge of chemical. There is a hand control adjustment for varying the amounts of chemical.

After the chemical leaves the dry feed, at the discharge end there is placed a hopper or tray for dissolving the chemical and mixing it with water before it is injected into the raw water at the mixing chamber. This dissolving hopper is

arranged to give a thorough mixing before it goes to the settling basin.

The dry feed machines have a storage capacity of about 10 cu. ft. and have cut-off gate at the entrance to the dry feed machine. The machines are operated by electric motor with speed reduction through a worm and worm wheel and with a series of spur gears and pinions with jaw clutch to permit of changing the speed rapidly.

Water is taken from the pressure main supply line, run to the mixing box through a 1-in. galvanized wrought iron pipe and from that point the chemical solution feed is carried to the mixing chamber at the coagulating basin.

The discharge chemical feed pipe for alum and iron is of lead piping with lead line and cast iron fittings. The discharge piping for lime solution is of black wrought pipe with malleable fittings. Valves on alum or iron solution lines are flanged and made of acid-resisting bronze and valves on lime solution lines are entirely made of iron.

As the chemical is fed into the mixing chamber at the head of the settling basin, the water flows through the settling basin in the customary manner, is brought to the filters, passed through the filters to the clear water reservoir below and is then ready for pumping to the storage reservoir on the hill.

The filters are equipped with all the customary rate control devices to secure proper operation. The equipment includes Simplex Venturi effluent rate controllers, loss of head gauges, clear water depth gauge, and all necessary valves and stands for easy operation. The filters will have 27 ins. of silica sand and approximately 18 ins. of graded gravel. The strainer system will be cast iron manifold with wrought iron laterals with slotted holes, the slots being on the bottom side.

*Guarantees*

Guarantees call for an average reduction of not less than 97 per cent when the bacterial count exceeds 3,000 per c.c. in the raw water. When there is less than 3,000 bacteria per c.c. there is not to be over 100 bacteria per c.c. in the filtered water. The wash water requirements are not to exceed 3½ per cent of the filter capacity. In this connection it might be of interest to know that the old filters being replaced use all the way from 10 to 20 per cent of wash water.

Chlorine treatment will be fed as a germicide into the filtered water, and during periods of acidity, low alkalinity or times of vegetable discoloration this will be taken care of by proper quantities of soda or lime applied to the raw water.

*Main Power House*

The main power house of the French Lick and West Baden utilties is located in the rear of the Homestead Hotel adjacent to the old plant, the reason being that exhaust steam is used for heating the hotel and heating water for the baths. This hotel has a regular trade and is not seasonal, therefore there is a uniform demand for the exhaust steam, the large portion, of course, being used in the winter. In the summer, as there is an ice plant used in connection with it, there is also a demand for exhaust steam, so that the matter of operating the plant condensing was not necessary, and this was agreeable, as the matter of condensing water would have been a somewhat serious proposition and would have meant using cooling towers or a spray pond. The matter of economy therefore was one that must be determined on a non-condensing basis. It was also desirable to keep the equipment as simple as possible. For this reason reasonably good steam pressures were used and the use of superheaters decided upon in order to get good economy.

The old light and power plant has been in operation a considerable number of years and supplied power and light to West Baden and the electric pump. The power and light for French Lick has been procured from the French Lick Springs Hotel. The voltage used at the utility plant is 220 volts direct current, and the voltage for French Lick is 110 volts direct current, so that there has been no interconnection between the two towns, the company generating part of its power and purchasing part of its power, which, of course, has not been conducive to economical operation.

*Steam Turbine*

The old power plant was housed in a frame structure subject to great fire hazard and both the generating units and the boilers had reached such a condition that it was found necessary to rebuild at once. About a year ago one of the direct current units broke down, leaving only one unit, and at that time immediate steps were taken to rebuild the plant first procuring a temporary unit to keep the plant in operation. For this purpose a 100 k. w. Curtis steam turbine was purchased, shipped by express from New York and placed on the foundations within a couple of weeks after the old unit had gone to pieces. This turbine has

now been running for almost a year, carrying practically the entire load with the exception of French Lick.

*Engines and Boilers*

As the loads in the new plant will have some variation, and like all lighting utilities, will have a peak, also a fairly low point. Unaflow engines were found to give the best overall economy under these conditions. Three boilers are being installed, each 300 H. P., Erie City vertical boilers and Type E Combustion Engineering Corporation stokers, using forced draft. Boilers are good for 180 lbs. pressure, but the plant will be operated at 165 lbs. Each boiler is equipped with a Whitlock superheater which will give 100 deg. of superheat. The boiler plant equipment is guaranteed to give 175 per cent. rating. Efficiency guarantees call for 74 per cent. at 150 per cent. rating with 11,000 b. t. u. coal. The coal will be fed to the stoker hoppers by coal elevator directly from the coal storage bins.

*Coal Consumption*

It will be of interest to note the amount of coal used in the different plants in this valley.

The utility plant and the two large hotels use approximately 75 tons of coal per day average the year round, so it can be realized that the combination of any of the different services is going to result in considerable saving. While, of course, the new plant does not contemplate taking on all of the heating or lighting loads, even with what has been added to the power house in the way of new loads, this combination will result in a considerable overall saving for all concerned who are connected thereto.

The generating equipment consists of two 219 k. v. a. horizontal Ames Unaflow engines with General Electric generators and one 500 k. v. a. unit consisting of an Ames vertical 4-cylinder Unaflow engine at 277 r. p. m., direct connected to 500 k. v. a. General Electric generator. The generators are 2,300 volt, 3 phase, 60 cycle. The control of the electric equipment will be through a 12-panel switchboard controlling the various units and circuits outside the plant.

The above mentioned vertical engine is of especial interest, as it is the most recent development in Unaflow engines, the speed being almost double what is usually found on units of this capacity, and it is also arranged with a high pressure oiling system in much the same manner as an automobile engine. One of the reasons for selecting this type unit was the fact that it saved considerable space over the horizontal equipment and gave very good economy. This unit will be installed in about 60 days.

The power house contains all the necessary auxiliary equipment, the boiler feed pumps being outside center packed, also feed water heaters for both exhaust steam and hot water service to the hotel; the blower system for stokers consists of an engine-driven blower and auxiliary turbine blower reserve.

The ice plant is being rearranged to become a part of the finished plant. This consists of a complete 30-ton ice making capacity compression system used for ice making and refrigeration.

The entire light and power plant, the ice plant, cold storage and refrigeration, also the laundry for the hotel service will all be at the same location so that the operation of this entire equipment will be conducive to good economy for the entire system.

*Distribution System*

The entire present distribution system consists of direct current, and this is being changed over to alternating current; 220 volts is used in West Baden and 110 volts in French Lick, but the entire system will be changed to 2,300 volt primary lines and 110 volt lighting and 220 or 110 volt motor service. The street lighting systems of the two towns will be changed to series incadescent lighting systems. The matter of changing this entire system over will, of course, take some little time, as service must be rendered continually.

The power house is about ready to start up and as soon as the piping is finished the steam will be cut off from the old boilers and connection made from the new boilers to the present direct current steam turbine unit. The alternating current units will also be operated and the lines gradually changed over, after which time the direct current units will be abandoned.

The pumping station will be operated entirely by electric motor except in case of break down in the transmission line, at which time the gasoline engine can be used.

When this new equipment was decided on a little over a year ago it was not contemplated to have as much capacity as is now being installed, but it was found that the additional loads that it was possible to secure would entail more capacity and the size of the plant has therefore been almost doubled.

Practically all work has been done by

local day labor under the supervision of the engineers. Mr. Geo. T. Gilbert, resident engineer for Chas. Brossman, is in charge of all construction work. The power house is nearing completion; two boilers and two generating sets are completed, one additional boiler and additional generating unit of 500 k. v. a. capacity will be installed within the next 60 days. The contracts for the filtration system have been let, but work cannot be started on this until after the spring high waters.

It is expected that this plant will be the ost modern non-condensing, medium-sized generating station in the State, and will make a very good record for economy.

The foregoing paper by Mr. Brossman was presented at the 1924 meeting of the Indiana Sanitary and Water Supply Association at French Lick on March 6.

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# WISCONSIN'S NEW 10,000 MILE STATE TRUNK HIGHWAY SYSTEM

*By J. T. Donaghey, Maintenance Engineer, Wisconsin Highway Commission, State Capital Annex, Madison, Wis.*

The state of Wisconsin has approximately 78,000 miles of public highways of all classes. In 1917 our legislature provided for the state taking over a 5,000-mile trunk highway system, the maintenance of which was to be done by the counties in which such system would lie and paid for by the state out of motor vehicle license funds. The maintenance of this first 5,000-mile system under the law commenced April 1, 1918. Probably not to exceed 50 per cent of the mileage had been previously improved by state or county construction; therefore, we were tackling a rather large job when we proposed to maintain one-half of the 5,000-mile system in an adequate manner for traffic, where it had not been previously improved in any systematic manner nor had there been probably more than one-third of the 5,000-mile system improved with any kind of surfacing whatever.

### *Patrol Maintenance*

A system of patrol maintenance was adopted by the Highway Commission, and on April 1, 1918, 640 patrolmen took actual charge of maintenance on the new system. The plan of patrol maintenance was immediately very popular. It increased the service to traffic fully 100 per cent and created a demand in the minds of the people for more road service of that kind. The cost of patrol maintenance the first year averaged $190 per mile and has increased annually with increased traffic until, in 1923, the average was nearly $300 per mile.

### *Marking Original System*

The original system was marked by painting a white band on telephone poles at proper points, placing thereon in black a triangle 10 in. wide and 14 in. in depth, containing the number assigned each highway. The longest highway at that time was State Trunk Highway No. 10, which covered a distance of 460 miles, extending entirely north and south through the center of the state. Direction signs were placed where necessary to direct traffic properly, and the motor public in general felt that a wonderful forward step had been taken in highway marking.

### *State System Extended in* 1919

In 1919 the legislature was besieged with requests for additional trunk highway mileage. Those living along the marked State Trunk Highways saw the benefit derived therefrom, and those not on such system wished to be placed on equal footing with the others, especially the small business centers throughout the state. The 1919 legislature met the demands of the people and authorized the addition of 2,500 miles to the State Trunk Highway System to be maintained in the same manner as the original 5,000 miles after April 1, 1920. The same provisions were made for marking and signing, and after the addition of the new 2,500 miles in 1920, resulting in a total of 7,500 miles, the system was renumbered properly to take care of the new portions and at the same time was re-marked and signed.

### *Better Marking Demanded.*

Although our marking appeared very satisfactory to begin with, each year the public has demanded better marking and more complete detailed information on all our signs. This is especially true of the detour signs around construction work. All detours are now marked just as adequately as the regular Trunk Highway, for which they substitute.

In 1922, in addition to our direction signs and ordinary markers, signs were erected at the entrance of all cities and villages on the system, giving the name of the town and its population. In 1923

we went a little further with this particular sign and showed on the reverse side; that is, facing the driver when driving out of town, the name of the next town on the system and the distance to it. We also erected signs at stream crossings and at the approaches to lakes along the highway, giving the name of the stream or lake, as the case might be, our whole idea being to give to the public information that they desire when traveling our highways.

*State System Extended Again in* 1923

The legislature of 1923 was again requested to add more miles to the State Trunk Highway System. A few small centers of population were not on or close to the system. However, they were reasonably well served by a county trunk system, which at this time had nearly reached 10,000 miles. The county trunk highways were maintained, marked and signed just as adequately as the State Trunk Highways, but they did not carry the triangle and number of the State Trunk Highways, therefore those sections were not satisfied. They wanted to live on a State Trunk Highway.

These centers of population and the farmers living along the roads that the county trunk systems traversed were insistent in their demands that they be made a part of the State Trunk Highway System, and the legislature again granted their request and authorized the addition of another 2,500 miles to the system, resulting in a 10,000-mile State Trunk Highway System, the same to be taken over for maintenance April 1, 1924, and marked and signed in the usual manner. Each time the legislature made provisions for increasing the State Trunk Highway System, a committee of five members of the legislature was selected by the Governor to act in conjunction with the Highway Commission in selecting such system, and each time hearings were held at all county seats to discuss the requirements in that county and get the local viewpoint in so far as possible as to the roads that should be added to the system in each community. At the hearings held in the several county seats during the summer of 1923 for the purpose of selecting the last 2,500 miles to be added, the residents of the state asked for more than 12,000 miles of highway to be added to the system, with the possibility of adding but 2,500 miles, the amount authorized by the legislature. This gives some idea as to the demands of the people for a larger State Trunk Highway System.

STANDARD TURN, DETOUR AND CROSS ROAD SIGNS USED ON WISCONSIN HIGHWAYS.

*Counties Relieved*

As stated before, the counties maintained in 1923 approximately 10,000 miles in addition to the 7,500-mile State Trunk Highway System, or a total of 17,500 miles. The 2,500 miles newly authorized would, of course, be the most important portions of the 10,000-mile county trunk system. This would naturally relieve the counties of just that much maintenance costs.

We are satisfied that from 85 to 90 per cent of the population of Wisconsin lives within two miles of the new 10,000-mile State Trunk Highway System, and probably more than 95 per cent live within the same distance to either a State Trunk

or County Trunk Highway. This gives practically all our farmers a well-maintained highway to their market at practically all times. It also furnishes a well-marked highway for city motorists as well as for our visitors.

*Renumbering and Marking the New System*

A large majority of our Trunk Highways are surfaced with gravel or some kindred light surfacing, which takes care of traffic very adequately up to about 400 vehicles daily. When traffic exceeds this figure many of our gravel roads deteriorate rapidly and we have found in the past that the continuous numbered highways attract traffic which eventually overloads the light surfaced roads. Strangers coming to the state, look at a map and find Trunk Highway No. 10, north and south, or Trunk Highway 19, east and west, give them a continuous number to follow in the direction they wish to go. They will then stick to that highway, even though there may be another paralleling the one they selected equally as good or better, carrying considerably lighter traffic and one which would have been safer and more pleasant for them to drive. Experience has taught us that the public desires continuous numbering. They do not wish to learn football signals, if possible to avoid it. We have, therefore, determined in numbering our new system to select just as many continuous routes extending entirely across the state in all directions as is possible. We believe that paralleling continuous routes will distribute traffic, thereby relieving the congested routes, making it safer and more convenient for the public to use our highways and also postpone the date of rebuilding or resurfacing many of our important highways that are now covered with light surfacings.

Under our old system of marking, we had but one State Trunk Highway that extended continuously from one end of the state to the other, north and south, and had but four across the state, east and west. Under the new plan we will have twelve extending continuously across the state north and south, and thirteen east and west, containing 7,500 miles, or 75 per cent of the total State Trunk Highway mileage, or an average of 300 miles each.

Due to renumbering the system along these lines, probably 50 per cent of the old 7,500-mile system will be changed more or less. We have, therefore, decided at this time to get away entirely from marking the system by the use of telephone poles along the roadside and erect special markers along the shoulder about 16 ft. from the center line. A special metal marker facing both ways will be used and so erected to permit automobile lights at night to catch the number readily. The greatest objection to using telephone poles to carry road markers is that many times they are located in such a manner that it is almost impossible to see the numbers readily with the ordinary automobile lights. We are satisfied that the cost of renewing the markers on telephone poles over a five-year period is greater than it will be to maintain separate markers along the shoulder of the road. The cost of renewing markers on telephone poles ranges from 75 cents to $1.00 each, and this must be repeated at least every second year to be satisfactory. The cost of separate markers in place will not be more than $2.00 each, and will last at least three years and possibly five before replacement is necessary.

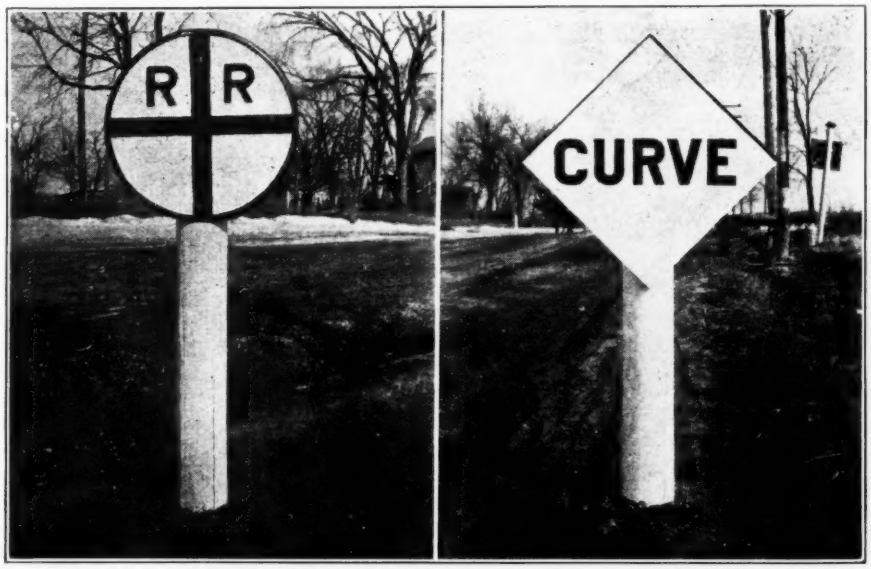
We find that, to mark a system adequately for strangers to use, we must have from three to four markers per mile. This is especially true in the more densely populated sections of the state where important road intersections are encountered very frequently, requiring a marker each side of each intersection in order to assure the traveler that he is on the right road.

*Shape Warning Signs*

In addition to the special markers, we will place the required number of "shape warning signs" recently adopted by the Mississippi Valley Highway Association. In explanation of the "shape warning" signs" will say that Wisconsin as well as several of the Mid-Western states, has for years used a circular warning sign 2-ft. in diameter in advance of all railroad crossings, and the public has become educated to know that a circular sign of this size seen in the distance means they are approaching a railroad crossing. We believed the same idea could be applied to all hazardous conditions on or along the highways by selecting a certain shape for each of such conditions. Therefore, the Mississippi Valley Association at its 1923 meeting decided upon the following shapes: Round, railroad crossing; octagonal, stop; diamond, slow; square, caution; and in addition Wisconsin is using an oblong sign to indicate

that the road you are on "turns" abruptly. These signs are all 2-ft. in the shortest dimensions, except the "turn" sign, which is 40x20-ins. The words "danger,' "caution" or "slow" are never permitted on warning signs. The meaning of the round sign, as stated, is that you are approaching a railroad crossing. The octagonal sign that you are approaching an arterial highway or other reason for coming to a complete stop.

The meaning of the diamond shape sign is "slow;" that is, when you see one ahead, get your car under control as there is a condition of the road itself that is hazardous, such as a curve, hill, loose gravel, etc., where the driver should proceed slowly. The square sign means there is a hazard ahead, not of the road, but along the road, requiring you to proceed with caution in order not to cause damage to others, such as school houses, cross roads, etc.




STANDARD RAILROAD AND CURVE SIGNS USED ON WISCONSIN HIGHWAYS.

*Shape Signs Recognized at 1,000-ft. Away*

We believe that when the public becomes reasonably well educated as to the meaning of "shape signs' in the Middle-West, they will be a great factor in the prevention of accidents. We believe the shape sign seen in the distance will have a much greater effect on the driver than any wording that could be placed upon a sign that he might read when near enough to do so. The shape can be recognized for 1,000-ft. or more, where wording or colors can not.

It is now costing approximately $10 per mile annually to mark and sign our system. The cost is gradually increasing each year to the extent of the motor public's demand. We estimate the cost of renumbering and marking in 1924 will reach $15 per mile, but we know it is worth it. The public in general feel more friendly to expenditures for marking, signing and maintenance than for any other highway work.

*Serving Traffic*

Our whole aim is to serve traffic in the most adequate manner. In 1924 there will be approximately 1,300 patrolmen employed on the new 10,000 mile State Trunk Highway System, and we have available for the maintenance of this system $3,250,000. The counties will maintain 10,000 miles or more of county trunk highways, employing no less than 1,100 patrolmen and have available for maintenance on the county trunk system $2,500,000. We will, therefore, have adequately maintained in 1924 a total of 20,000 miles.

We expect within a ten year period that the demands of the public will compel the state taking over at least 50 per cent of the present county trunk system, resulting in a 15,000 mile State Trunk System, and that the counties in turn will

take over an additional mileage of town roads which will eventually result in 30,000 miles more being adequately maintained, marked and signed annually. This will be more than one-third of our total road mileage.

*Wisconsin Leadership*

In 1918 Wisconsin stepped out well in front of other states in adopting a number system of marking highways. Others have gradually followed, but we have tried to keep well in the front ranks of our sister states from then until now. In 1924 we will again step out in front and give to the public the best and most completely marked system of highways in America. Our individual markers along the roadside, the shape warning signs, city and village signs (telling you where you are), the lake and stream signs, the general direction signs, together with the practically perfect marking of detours, combined with the continuous numbering of our 10,000 mile system will make it an increased pleasure to tour Wisconsin.

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# LABORATORY CONTROL IN WATER PURIFICATION

*By Jack J. Hinman, Jr., Associate Professor of Sanitation, University of Iowa; Chief, Water Laboratory Division, Iowa State Board of Health, Iowa City, Iowa*

The amount of laboratory control work that is done on the operation of a water purification plant is usually determined by the amount of money that the directors may be persuaded to appropriate for the purpose, and is not likely to be determined so directly by the needs of the particular plant and its peculiarities of source, equipment and demand. But this is so nearly the usual condition in other human enterprises that it might almost be passed as if it were taken for granted.

*Reasons for Laboratory Control*

The board of directors, and, indeed, the superintendent or general manager of the plant, may not be competent to understand or realize the actual desirability of the work nor the extent to which the work is necessary. The demand for the laboratory control frequently has had its origin in the requirements of the local or state health departments or the insistence of civic bodies of one sort or another.

Naturally the larger and older water plants were caused to see the need for water laboratory work long ago. The larger plants, with their technical personnel of experience and training, are better able to appreciate the benefits which may be derived from scientific work. Consequently they may reap the fruits of the foresight of their executives in increased safety of the water they supply, as well as in increased public confidence, in the more economical operation of their plant equipment and the purchase of supplies, as well as in such forward-looking matters and developments, protection and the devising of new methods.

In general the smallest plants must be restricted to the routine analytical control of the water by the employment of a few simple tests, and to the opportunity to notice variation from the normal in the raw water supply with consequent indication pointing to the required changes in the treatment as applied, or to the necessity of securing more highly trained technical help for the emergency.

In order to give one an idea of the possibility of the water laboratory and of the work which it may be developed to do within its own field, the following tabulation has been prepared. It is reasonably complete, but it does not exhaust the possibilities of service.

*The Work of a Water Laboratory*

1. The routine bacteriological examination of water. Purpose: To note the change in quality of the water so that the source of an untreated supply may be protected. To note changes in the quality of the raw and treated waters of a purification plant, so that necessary changes in the treatment may be applied. To see that the public is warned in an emergency.
2. The routine sanitary chemical analysis of water. Purpose: In general to supplement Item No. 1 and to allow the operator to know in advance of the time necessary for the completion of bacteriological examinations that changes in the supply have occurred.
3. The routine mineral analysis of water. Purpose: To assist the local industrial plants in applying treatment to the water from the public supply. To supplement Items No. 1 and 2, as desirable.
4. The routine analysis of chemicals used in water purification. Purpose: To assure uniform quality

of chemicals. To aid in the economical purchase of these supplies.

5. The analysis of coal, flue gases and other boiler-house supplies. Purpose: To operate the boiler house to the best efficiency. To secure economical purchases. To secure the quality of supplies desired.
6. The analysis of miscellaneous department supplies. Purpose: To assist in economical purchasing and to secure the type of supplies best adapted to the work in mind. Note: When the water department is municipally owned, this phase of the work may be extended to other departments.
7. The survey of possible new sources of supply. Purpose: To provide economically and sufficiently in advance of need, for extension to the plant and to assist the directors in applying a policy of extension along the most desirable lines. (Involves laboratory and field work.)
8. Supervision of existing sources. Purpose: To seek out hidden dangers to the continuity and safety of the supply, with a view to removing those dangers. (Involves laboratory and field work.)
9. Study of plant methods. Purpose: To apply the methods at present provided with the maximum efficiency and the minimum cost. To investigate the applicability under local conditions of methods recently noted in the water works literature. To devise new methods applicable to the particular case of the water plant under consideration.
10. The compilation of records on the supply for comparison with the public health records of the community. Purpose: To demonstrate needs in the treatment processes. To demonstrate the connection of the improvement in the water supply with improvement in the public health of the community. To show the water supply guilty or innocent in connection with epidemics of intestinal disease.
11. Research in analytical methods. Purpose: To assist in development of laboratory technique. To adapt new methods to the routine control of the water plant, so that more accurate and more useful analytical data may be available.
12. Preparing publicity material. Purpose: To supply models, charts and other exhibit material and press stories to keep the water department and its needs and efficiency before the public.

In order to carry out the full program that I have outlined, there would be needed a well-trained laboratory man, and probably several assistants. They would require a well-equipped laboratory, a good supply of materials, and some means of transportation. The co-operation of the superintendent and the operators would be necessary also.

*In the Small Plant*

In the small plant a program of this sort is impossible. It is not feasible on account of expense. In some of the tiny plants that we have in Iowa any laboratory at all would be out of the question. You cannot support much laboratory control on the income from 10,000 gals. of water a day. However, because the ordinary small water purification plant cannot support the entire organization that those controlling large water plants recognize as essential, the operators of the smaller installations should not be blind to the advantages that they are able to secure for themselves. Of course they should take full advantage of the assistance that the State Department of Health stands ready to offer. The large plants need this assistance, too, and they should be accorded it. But the work of the State Health Department is usually only supervisory. It wishes to assure the public safe drinking water. It is willing to send help in an emergency, and it is willing to give such advice as its technical personnel can supply. It can not give the small water plant continuous analytical control, and it cannot keep its men constantly on the ground to take the responsibility of suppling safe water every hour throughout the year.

But the organization of the small water works plant can, as I have already indicated, do something for itself. It can at least carry on a sort of bacteriological control, and it can carry on at least a few determinations on the physical condition of the supply. Perhaps it can even do more or less complete chemical analyses, as determined by its needs.

*A Trained Man*

Naturally enough, if the plant can carry the expenses without too great a burden, an adequately trained man should be secured as chemist, or superin-

tendent of filtration. He should be intrusted with the conduct of the analytical work, and provided with such assistance as is necessary. If it is impossible to justify the employment of such a man as I have indicated, perhaps the superintendent or the chief engineer may qualify to do the necessary work. These men may gain a sufficiently complete knowledge of the technique to enable them to carry on a few tests in a comparatively short space of time. This they may do by attending operators' schools, by getting special instruction from the laboratory men of the State Health Department. If they are sufficiently interested and persistent, they may get the information by the reading of books and by the repetition and study of the analytical work.

In some cases it has been possible to get the science teachers in the local high schools to carry on the laboratory work. But it is only exceptional when these people are specially qualified in water laboratory work. They are likely to be able to carry out the analytical determinations if provided with copies of compilations of methods, but care must be taken to see that they do not put wrong interpretations on the results of their work. It is likely that undesirable and undeserved publicity might be the outcome if results of partial or inconclusive tests are published. For instance, gas production in lactose or dextrose broth is pretty generally considered to be a bad indication in a water, but if the results of the test are published without any further attempt at identifying the bacteria which produce the gas there is serious danger of a treated water supply receiving undeserved criticism. Some lactose fermenters that are harmless in themselves defy the usual chlorine dosage. It is necessary to show that other bacteria than these caused the positive fermentation test. And there are other possibilities of error that should be appreciated.

*Interpretation of Tests*

Who is to put the interpretation on the tests? This is a matter of importance when the tests are made locally by persons whose training in water supply matters is deficient. Frequently the water department men are not able to interpret the results. The State Health Department usually maintains a staff of technical men, among whom should be at least one who can assist in this matter. He should endeavor to do what he can without putting any police power into the foreground. The water plant operator should get such assistance as he needs. He should be encouraged to do this by the State Department of Health, and his faith in the Department's desire to help him should be cultivated carefully. But as fast as he is able to do so, the water works man should qualify himself to make his own deductions, checking them up perhaps by conference or letter. It must always be remembered that the local plant operator is likely to have to make some decisions about the treatment of his water supply and its safety in a very short space of time, and that upon the correctness of his judgment and on his promptness of action may rest the avoidance of an epidemic.

*The Licensed Operator*

Water works operation in general, and water purification in particular, are technical matters, as most of us realize. Licensing of operators of water treatment plants as practised in Texas and a few other places, is an excellent protection to the public. A good politician may be able to throw the vote of a ward or larger division of a community to a winning candidate, and yet, aside from testifying to his alertness from a political standpoint, this fact does not recommend him for the responsibility for the control of a water plant in view of all that the continuous and regular operation of the plant means to the safety and convenience of the industries and the individuals of the community.

Water works men who serve their communities adequately must study their plant, its needs and current water works practice. Nowhere is this more true than in the case of the operators of the water purification equipment. They need all of their wits, all of the help they can get from their local and state agencies, all of the assistance that close contact with state, divisional and national societies of water works men can give them. And they should do more than merely absorb the benefit of the work of other men. They also should be producers. They should put their strength back of movements for better, more economical, and more certain methods, equipment, and operation in the water purification plants of the country.

We all realize that the methods we use, both in the laboratory and in the plant, are far from perfect. Progress can not

reasonably be left in the hands of a few, or in the hands of the so-called high-brow element. It takes all of the men at work in the water supply industry to make it go forward as it should. Each little plant is an individual problem, and from each something could be learned. It is worth while to discuss the difficulties of these plants and for the operators to tell others of their troubles and successes. We do not any of us know too much about these matters. The operator need have no fear that his story will be too trivial to get an audience, and no one will fail to give him due credit for the thought and study that he has given his business. Thought and study as well as actual manual service over a definite number of hours is what we all owe our jobs.

But perhaps all this seems to stray a good way from the subject of the laboratory control of a water plant. What I am trying to suggest is that only by study of the operation and needs of your particular plant can you decide on the best line of control. You can by no means conclude that the determinations made or the type of control applied to the neighboring plant is best adapted to your needs.

*Intensive Study*

To the person starting a laboratory to work upon a particular water supply my advice would be to embark on as intensive a study of the supply as is possible. If necessary, and it can be done, temporary additional help should be employed. The different determinations made should be studied closely to see which ones are best adapted to show significant changes in the quality of the raw water.

Bacteriological examination should be made at all events, but they have the objectionable handicap of taking several days before the full meaning of the results may be known. Study to see if there is any correlation between unsatisfactory bacterial quality in the raw water and some particular chemical tests. Then select a program of work within the limits of the funds and equipment available and proceed. (It may not always be the scheme you would prefer, of course.) But don't take the view that the matter is settled for all time. Changes in the character of the supply may be brought about by reason of the changes in the amount and composition of the sewage and industrial wastes led into the stream nearer its source, as well as by other uncontrolled causes. These things may alter the value of the determinations originally selected.

*Local Value of Various Tests*

On one supply in which I have been interested I made several thousand nitrogen determinations before I could fully convince myself that the information I obtained was not sufficiently valuable to justify the outlay in time and chemicals. At that, I think I should have realized it sooner. But up at Toronto Mr. Norman J. Howard has said that he finds ammonia determinations most helpful to him in indicating the manner in which the lake currents sweep the sewage toward or away from the water works intakes.

In some other places the oxygen consumed test is used as being of greatest value in noting changes in the character of the raw water. In other places other determinations are regarded as most significant. I suppose that the most commonly made determinations of all are those of color and turbidity. They have the advantage of being most easily demonstrable to the untrained operator.

The alkalinity and the hydrogen ion concentration are valuable determinations at rapid sand filter plants, and are often run in connection with coarse tests to determine the effect of the water and varying amounts of aluminum sulphate. There is a lot that we do not know about the most effective way to obtain our ends in the precipitation of aluminum hydrate, but it is making no novel statement when it is said that under most conditions of operation an idea of the most favorable hydrogen ion concentration for the particular supply is generally helpful. The fact that at times of freshets and with change in the character of the raw water comes a lessening in the value of the determination as indicating correct conditions for treatment may be urged as affecting the desirability of the determination. However, most of our processes and the results of our experience are hard to apply to unusual circumstances, and we ought to avail ourselves of every aid we can secure.

*Chlorination*

And when we have filtered the water and taken it sparkling and clear from the outlets of the filters, we have still further need to watch the second line of defense which we usually throw about the safety of the supply. Nowadays we do not feel

that it is a good idea to depend on the filters alone to furnish us a safe water, and so, as we all know, we call chlorine to our assistance. But different waters absorb chlorine at different rates. This again is due to a large number of uncontrolled factors about which we know little in detail and much in general. As a rule, the more polluted the raw water, the greater the chlorine absorption and the greater the need that the full effect of the chemical shall be realized. The chlorine has the objectionable property of forming additional products that are possessed of flavors distasteful to the public. Sometimes the taste imparted hardly seems to be proportional to the amount of chlorine used. This is very likely to be true if the wastes from gas plants, and other phenol-producing industries are in the water. It has been claimed that over-chlorination and subsequent treatment to remove the excess chlorine after a definite period of contact may avoid some of these bad tastes. I have never tried this on a large scale, and so I can not verify the statement. At any rate, we need to be sure that we get in enough chlorine to do the work we expect of it, and at the same time it is desirable from motives of economy and a desire to avoid taste not to get too much. Tests with orthotolidine or some other re-agent to determine the presence of chlorine after a definite period are useful in checking the working of the apparatus, and the consumption of the chemical. Sometimes the range between a sufficient amount and an objectionable excess is not very great.

In making the tests to determine the consumption of the chlorine an attempt to imitate the condition at the plant may well be made. If the chlorine is fed to the water just as it goes out into the pipe system, the samples taken should be held in filled and stoppered bottles for the required contact period and then tested. If the discharge of chemical is into water to be stored in an open clear-well, an open bottle better represents the conditions. Bottles containing samples should be shaken as little as possible before the addition of the re-agent, In some work that I did on a French water plant I noticed that there was a discrepancy in the results obtained upon the chlorination of the plant, even when samples were taken at almost the same time, held for identical periods and tested. In one case the tests were all carried out at the French plant. In the other the test for free chlorine was made at the Army laboratory. I have attributed the difference to the shaking that the samples got in going from the plant to the Army laboratory in a sidecar over cobbled roads.

Having determined the rate of chlorine absorption for any particular occasion, one should be able to tell how long a sample has been in the main, providing of course that there is enough residual chlorine to be measured. This might not be especially valuable in determining the rate of flow because of the action of varying demand on the lateral pipes between the point of sampling and the plant. But in a long supply main from the plant to the town it would enable the operator to determine whether a sufficient length of time elapsed between chlorination and removal from the pipe to allow full sterilizing effect of the chemical.

These chlorine absorption tests are simple, especially if the standard solutions are made up by an experienced person. Any operator should be able to carry through the test. Several state health departments are now furnishing the materials and requiring that the tests be made by the chlorination plants.

And for that matter some state health departments are insisting on the installation and operation of laboratories by all treatment plants. Desirable as this may be, I doubt the wisdom of applying this regulation to the plants in Iowa at the present time. As I have indicated, many of our Iowa plants are very small. We have a large number of plants in Iowa. There are over 500 of them, and more than fifty treatment plants. Some of these purification plants supply water to large cities—as cities go in Iowa. A few of these plants have their own laboratories operated by graduate chemists, a few others make use of the local branch laboratories of the State Department of Health, some have laboratory equipment which is used by the superintendent or the chief engineer, and we endeavor to see that all of them keep in as close touch with our Water Laboratory Division as possible.

Constant watchfulness is essential to safe operation of a water supply plant, whether the water comes from wells or from surface sources prior to treatment, although of course in the case of the latter especial care is necessary. We need every aid to the senses that we can

secure, and we can get a part of this type of help from our analyses. Frequent bacteriological and chemical examinations carried out on the spot are most desirable. If it is impossible to obtain these, then regular examinations should be made elsewhere and the interval between the tests should be as small as possible. In no case should a water purification plant go longer than a month without making an attempt to check up on the sufficiency of the treatment. We all know that the quality of waters of streams sometimes changes in a matter of minutes.

The foregoing paper, by Professor Hinman, was presented before the recent annual meeting of the Indiana Sanitary and Water Supply Association.

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# INDIANAPOLIS DEVELOPMENTS IN GARBAGE REDUCTION

*By E. W. McCullough, Consulting Engineer, Board of Sanitary Commissioners, City Hall, Indianapolis, Ind.*

The Indiana state law requires that every householder shall provide a tight metal garbage can with a tight-fitting cover. Garbage must be kept separate from ashes and refuse. Corn husks are considered rubbish.

The garbage from all parts of the Sanitary District of Indianapolis is collected twice each week, from May 1 to November 1, and once each week from November 1 to May 1.

*Garbage Dewatered in Trailers*

Dewatering devices have been installed in all of the trailers used for the collection of garbage. When a collector has filled his trailer about one-third full he draws up over a convenient sewer manhole and drains the free water from his trailer. The same process is repeated when the trailer is about two thirds full. The trailer is again drained when it has received its entire load and is ready for connecting in train for haulage to the plant.

The dewatering device, in a general sense, consists of a perforated plate placed over the entire bottom of the trailer. The garbage is dumped into the trailer from the individual household container and as the trailer rattles, bumps and shakes along its route through the alleys the free water contained in the garbage is drained from the solid content and settles into the water receiving compartment in the bottom of the trailer. It will be noted that the shaking is done after each small lot of garbage is dumped into the trailer, thereby giving the garbage every opportunity to rid itself of its free water content.

After the garbage has been hauled to the reduction plant the water that has shaken out during the long trip by truck and trailer is drained off. Provision has also been made for draining the present receiving station. Instances have been noted where as much as 150 gals. of free water have been drained from a single trailer. This takes into consideration all drainings from the time the collection starts until the garbage is finally ready for dumping into the receiving station at the reduction plant. The perforated plate is so arranged that even the trailer water receiving compartment is cleansed when the trailers are washed after dumping each load. Prior to installing these dewatering devices the department was flooded with complaints against the spillage of garbage water along the streets. This spillage caused both odor and fly nuisances and was a real menace to public health. Since installing the dewatering device no complaints have been received in spite of the fact that each 3½-yd. water level capacity trailer now carries a load of four tons instead of the usual 2½ tons carried when the complaints were being received.

*Odors Reduced*

In my opinion it is the free water content of the garbage that causes the rapid deterioration of the solid portion. This is borne out by the fact that since the campaign of dewatering was inaugurated the odors emanating from the receiving station have been reduced to a minimum, and it is remarkable to note the exceedingly fresh condition of the garbage at the time it is ready for dumping into the cooking tanks. Better results have been obtained at the plant since cooking the fresher garbage, and the products are of superior quality.

There is very little accumulation of garbage at the reduction plant. With the plant now in existence the garbage is reduced daily within 18 hours from the time it is delivered to the plant. In the summer time there is a little greater accumulation, but the present receiving station is so small that not more than 24 hours' accumulation can be allowed, otherwise the pit would overflow.

*The Present Plant*

In the present reduction plant there are 16 Chamberlain digesters. Each holds about 4½ tons of green garbage. The most that can be done in 24 hours with any degree of satisfaction is to cook 24 tank loads. After cooking, the garbage is discharged from the tanks by manual labor and piled in a pit in front of and below the digesters. From the pit it is run through a direct heat drier, thence to a percolator and finally through the direct heat drier again and to fertilizer stock bins. The cooking in these digesters is unsatisfactory. The tankage in the pit below the cookers often begins to deteriorate before it can be sent through the remainder of the process. It sours and ferments very rapidly, because it is hot and wet when it is discharged from the digesters. On going through the direct heat drier the tankage is scorched and burned.

*The New Plant*

In the new garbage reduction plant in Indianapolis, construction of which is now under way, the process will be entirely changed. The new process is the result of experimental work using full size equipment.

The same dewatering methods will be used during collection. This is the first important step in sanitary reduction. The receiving station garbage compartment will be very large. Ample drainage has been provided so that it will be impossible for the garbage to lie in the free garbage water. The green garbage will be taken from the pit mechanically and will be conveyed to the reduction tanks in the reduction building. There will be 32 Morrison sanitary garbage reduction tanks. In these tanks the whole cycle of operations is performed without removing or handling the charge until it is completely cooked and dried. This is an important feature of sanitary garbage reduction. By eliminating the direct heat drier the necessity of piling the hot, wet garbage is obviated and all danger of scorching and burning the tankage is eliminated. In brief, it converts the cooking and drying operations into a compact, sanitary operation quickly performed in the same tank. Each Morrison tank has a capacity of 3½ tons of green garbage under normal working conditions, and is capable of turning out two charges in 24 hours with every particle of the charge thoroughly cooked and dried. It will be seen from these statements that the garbage delivered at the plant will not be held over, but will be completely worked out of the receiving station within a comparatively short time after delivery.

After the garbage has been charged into the tanks fresh water may be added to the charge for cooking purposes. The tank is closed and live steam, at about 80 lbs. pressure, is admitted into direct contact with the raw garbage for a period of about three hours. Meanwhile the tank is vented and the pressure built up to 80 lbs. within the tank. The pressure period must be closely regulated. If the pressure is not built up quickly and held full during the entire cooking period the tankage will not be of superior quality. After cooking the charge is allowed to settle and the free water from the cooking process is decanted as far as possible, after which the charge may be steam pressed to further expel the free water.

After pressing, the charge is dried, usually under fifteen or more inches of vacuum, by means of a jacket into which steam is admitted. The charge is stirred or agitated and disintegrated while it is being dried. As a rule, the drying under vacuum proceeds for a period of about four hours.

When the tankage is dry it is automatically discharged into conveyors and carried to the preparation house. Here it may be degreased by the conventional degreasing methods, or it may be processed mechanically to remove from it the materials that are commonly termed "gut perforators," such as needles, pins, phonograph needles, tacks, book binding staples, glass, crockery, bits of wood and the like. It is not treated chemically or with solvents. There is no grinding in the preparation process. The glass and china are removed. All of the work is governed by chemical analyses of the strictest kind.

The following table gives a record of a number of batches made from the usual normal run of city garbage collected in Indianapolis. This does not include hotel or restaurant garbage. The reason that the hotel and restaurant garbage is not included is that this material is collected by private firms for direct feeding. None of it is received at the city plant. However, I am reliably informed that these private collections will be stopped as soon as the new plant is ready for operation. This should materially benefit the grade of tankage produced.

| Batch Number | Glass and China in Tankage as Discharged from Tank before being Processed | | Glass and China in Tankage after Processing | | |
|---|---|---|---|---|---|
| | % | Lbs. per Ton | % | Lbs. per Ton | Ounces per Ton |
| 1262 | 1.06 | 21.2 | .012 | 0.24 | 3.8 |
| 1263 | 2.68 | 53.6 | .016 | 0.32 | 5.1 |
| 1264 | 1.01 | 20.2 | .010 | 0.20 | 3.2 |
| 1265 | 1.28 | 25.6 | .006 | 0.12 | 1.9 |
| 1266 | 0.93 | 18.6 | .013 | 0.26 | 4.2 |
| 1267 | 2.53 | 50.6 | .009 | 0.18 | 2.9 |
| 1268 | 2.26 | 45.2 | .018 | 0.36 | 5.8 |
| 1269 | 2.38 | 47.6 | .050 | 1.00 | 16.0 |
| 1270 | 2.22 | 44.4 | .044 | 0.88 | 14.1 |
| 1271 | 2.98 | 59.6 | .037 | 0.74 | 11.9 |

The variation of the glass and china content in the finished tankage in the above runs is due entirely to experimental changes in the tests. The glass content can be regulated to a nicety. We have records of a large number of runs showing a greater elimination of glass than is shown in any of the above. All of the glass remaining in the finished tankage is exceedingly fine. The metallic content of the tankage after processing is nil. All metallics are removed.

The keeping qualities of the tankage made by this process are remarkable. Piles of it have been stored in the reduction plant, under most unfavorable conditions for many months. None of it deteriorated except where it was wet by rain or otherwise. Comparison of the keeping qualities of the tankage from the new process and the old was made by sealing samples from each process in air-tight containers. The tankage was all made the same day, from the same lot of garbage. The plant conditions were the same. In every instance the tankage from the old process rotted to dust by moulding while the new process tankage still remains in first-class condition.

*New Tankage Excellent for Feeding*

Some of the foremost scientists in Indiana and in the United States were consulted. All have stated that, in their opinion, this new tankage is entirely safe for feeding purposes, from every standpoint.

Horses, cattle, hogs and poultry have been fed on this product, and it seems to be very palatable to all of them.

The product has been fed to hogs for a period of over a year, and exceedingly satisfactory results have been obtained. Originally, the test hogs were fed on the product for two consecutive periods of one month each. The first period they received nothing but the product and water. They thrived and grew during this feeding period. This indicated that the material had a high food value, but the condition of the hogs indicated that the food was too concentrated and rich. During the second month, in addition to the garbage product, the hogs were each fed one ear of corn twice a day. When they were fed in this way a marked improvement in growth, weight and condition was noted, although it appeared that this diet was still too rich and concentrated. After these two months' feeding had elapsed the ration was varied still further, until it was found that the material could be profitably fed up to 50 per cent and that the hogs could stand that percentage.

Following this test, which demonstrated the food and conditioning values of the product, brood sows carrying fall litters were fed on it. The best results were obtained from a mixture of about 40 per cent of the product and 60 per cent of grain feed. These sows farrowed their pigs. Almost without exception they were uniform in size, well matured and developed, and possessed a far greater amount of vitality than usual. This herd has never had any sickness occasioned by this feed. Experience has shown that the product gives a balanced ration that is ideal for feeding hogs for fattening or for breeding purposes. On farrowing another litter of pigs, after the feeding had been in progress for over a year, experts pronounced the herd to be in the bloom of condition. The pigs were the most uniform in size, best developed, and possessed the most vitality of any pigs ever farrowed by this herd. These results are attributed by experts to the fact that these hogs were conditioned on this prepared garbage tankage for breeding, and were fed on it throughout the gestation period. Never at any time has there even been a suggestion of ill effects from it. There has never been a loss of a litter due to feeding it, even in ratios as high as 50 per cent. On the contrary, the condition of the herd has been markedly improved.

Certain hogs have been fattened for

market on a mixture of this prepared tankage, midds and bran.

It has been found that all of the animals butchered after being fattened on mixtures of this tankage had a firm fat and an excellent texture of flesh. It was stated by the judges that the condition of the animals was in every way equal to No. 1 cornfed.

In Indianapolis there is an engineer who is a poultry fancier and breeder. He was prevailed upon to try some of the prepared garbage tankage on his flock. The report follows:

"We commenced feeding this mixture about the 15th of October, and noted a marked increased in the egg production within a few days, and from the first of November to date we have been keeping a daily record of the eggs laid by our hens, which is in conformity with the daily record cards furnished you."

"Our flock of chickens is what is known as a regular farm flock of White Leghorns. In order that you may compare our production with flocks of like character under similar conditions, I would refer you to the following reports of flock production, taken from "The Rural Poultry Journal" publications:

| | Per Cent Production Nov. | Dec. |
|---|---|---|
| College View Poultry Farm, Alfred, N. Y. | 0.8 | 2.2 |
| Petaluma California Poultry Farm | 7.6 | 7.2 |
| Mass. Agricultural College Test on 14 Different Farms | 2.3 | 10.8 |
| Broad Acres Poultry Farm, West Chester, Conn. | 7.8 | 2.0 |
| Average Production | 4.6 | 5.6 |

"Taking this average production and figuring same on our 450 hens, their daily production for November should be 21 eggs, and for December, 25 eggs."

DAILY RECORD CARD—FEEDING PREPARED GARBAGE TANKAGE

—450 Hens—

| November Date | Eggs | Dec. Eggs | November Date | Eggs | Dec. Eggs |
|---|---|---|---|---|---|
| 1 | 68 | 142 | 16 | 144 | 163 |
| 2 | 73 | 140 | 17 | 127 | 165 |
| 3 | 70 | 145 | 18 | 138 | 167 |
| 4 | 76 | 138 | 19 | 136 | 170 |
| 5 | 82 | 132 | 20 | 140 | 164 |
| 6 | 90 | 141 | 21 | 143 | 172 |
| 7 | 100 | 147 | 22 | 145 | 166 |
| 8 | 120 | 136 | 23 | 147 | 164 |
| 9 | 116 | 132 | 24 | 142 | 170 |
| 10 | 124 | 145 | 25 | 145 | 173 |
| 11 | 136 | 130 | 26 | 140 | 180 |
| 12 | 140 | 147 | 27 | 147 | 166 |
| 13 | 132 | 132 | 28 | 143 | 160 |
| 14 | 140 | 153 | 29 | 142 | 164 |
| 15 | 143 | 166 | 30 | 146 | 168 |
| | | | 31 | ..... | 172 |
| Daily Average Production | | | | 124 | 155 |

"With the exception of feeding the prepared garbage tankage we are feeding and handling our chickens exactly the same as in former years, therefore we know of no reason except that resulting from the prepared garbage tankage addition to the feed which should cause the enormous increase in egg production for these winter months. During previous years our production has been comparable with the average in the citations given above.

"As to the value of the feed: If it will increase winter production when egg prices are high, even if the hens lay less in summer and thus only produce the average number of eggs for the year, you can readily see that this feed is more valuable than our regular mash, which costs $2.50 per 100 lbs., mixed to formula."

Tests have been made where the flock has been divided. Other tests have been made where the prepared tankage has been fed for a period and then removed from the diet. In every instance the production results reported are remarkable.

The foregoing paper, by Mr. McCullough, was presented at the recent annual meeting of the Indiana Engineering Society.

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# OUTSTANDING PROBLEMS IN HIGHWAY BRIDGE DESIGN

*By E. F. Kelley, Senior Highway Bridge Engineer, U. S. Bureau of Public Roads, Washington, D. C.*

### *Live Loads*

One of the first problems with which the bridge designer is confronted involves the selection of suitable live loads for design. This problem is an important one at the present time for, in this respect, highway bridge specifications have not kept pace with the great changes in traffic conditions which have taken place in recent years. An interesting illustration of this fact was brought out in a recent study of state specifications which showed that sixteen states were still using uniform live loads practically identical with those specified for Class B-1 bridges in Theodore Cooper's specifications of 1896. This shows the effect on modern specifications of a specification which was introduced at a time when there was no conception of the ex-

tent to which highway traffic would develop, both in density and weight.

*Specifications of 1896 Used in 1924*

Any live load specification should be based, as far as possible, on actual traffic conditions, and for this reason the selection of suitable live loads for highway bridges requires most careful study, since highway load units are not limited as to position, number or weight, and the characteristics of the different types of equipment which may use the highways are most varied.

Concentrated live loads which may be considered as producing the most severe stresses in ordinary highway bridges are motor trucks; trucks with trailers; road rollers; steam, gas and oil tractors; steam shovels, cranes and drag-line excavators, and military loads. O these, the various excavating machines and the heavier units of military equipment may properly be considered as exceptional loads, although provision must be made for them. In respect to weight and weight distribution, the heavier road rollers and tractors are very similar to heavy trucks and any specification which provides for the typical heavy duty trucks will provide amply for rollers and tractors. For this reason, and since motor trucks make up the great bulk of heavy highway traffic, the quite common practice of adopting them as representative of all heavy equipment is justified.

During the summer of 1921, information relative to a considerable number of truck models was collected and this material was presented as a portion of the 1921 report of the sub-committee on bridges and structures of the American Association of State Highway Officials. The data relative to weight, weight distribution and the more important dimensions show that, under-rated capacity loads, 5-ton trucks average about 10½ tons in total weight and 7½-ton trucks average about 13½ tons. But these are by no means maximum weights, as the overloading of motor trucks is almost universal and overloads ranging from 50 to 100 per cent are not uncommon. Under a 50 per cent overload, 5-ton trucks average about 13 tons in total weight and 7½-ton trucks about 17½ tons. Under heavier overloads these weights may approximate 15 and 20 tons, respectively.

What may happen in the way of overloading was well illustrated in some recent bridge tests. It was necessary to use heavy truck loads but no heavy duty trucks were available. A 3½-ton truck was loaded with gravel until the total weight was in excess of 14 tons, and was successfully operated for a considerable period of time. This is an exceptional case, but goes to show that a 3½-ton truck does not necessarily mean a 3½-ton pay load.

Under capacity loads, an average of about 77 per cent of the total load is concentrated under the rear wheels, and that with a 50 per cent overload the average load under the rear wheels is about 80 per cent of the total. Also that the average length of wheelbase is about 14 feet. These figures, which are of importance from the standpoint of design, may well be contrasted with the 10-foot wheelbase, and two-thirds of total load on rear axle which are quite commonly assumed in bridge specifications.

*Possible Future Loadings*

Of equal or even greater importance than the determination of present-day requirements is the consideration of what the future may bring forth in the way of increased highway loads. Legislation may temporarily restrict the weights of vehicles, but it will not do so indefinitely if new developments in truck and pavement design make possible the economic use of heavier units. It has already been quite definitely established that the damage to road surfaces depends on the wheel concentrations rather than on the gross weight of vehicle, and in this connection it is well to note the development of six and eight wheel trucks, which may make possible greatly increased gross weights without increased wear on pavements. We are today discarding thousands of old bridges which are still serviceable for the traffic for which they were designed, but which are inadequate for modern traffic. In order that the so-called permanent bridges which we are now building will not have to be discarded for lack of carrying capacity before they are worn out, we must consider, in designing them, the possibility of future loadings far greater than may now be considered probable.

That there is need for a modern loading specification and a more uniform practice with regard to live load requirements is made evident by a study of existing specifications. Considering the country as a whole there is undoubtedly need for several classes of loading, but the loads to be used should be based on present and probable future traffic conditions and not on state lines. State lines

do not ordinarily mark the boundaries between different classes of traffic and yet, under present conditions, they do constitute the dividing lines between live load requirements of greatly varying intensities. Thus, in crossing a state line, we may pass from bridges designed for one 15-ton truck to those designed for one 20-ton truck; from one 15-ton truck bridge to two 15-ton truck bridges; from two 15-ton truck bridges to two 20-ton truck bridges; all with no appreciable change in traffic conditions.

Three national engineering organizations are now working toward the standardization of highway live loads, and it is to be hoped that these three may be able to agree upon a single live load specification which will be adequate and suitable for general adoption and which may eliminate much of the present unjustified non-uniformity in practice.

*Width of Roadway*

The bridge is an integral part of the highway and should be so considered. Theoretically, therefore, the roadway width on a bridge should be the same as on the adjacent highway so that there will be no restriction of traffic due to the presence of the bridge structure. In the majority of cases it is not practicable to attain this ideal condition on account of cost considerations and we have come to regard it as a foregone conclusion that the more expensive structures will necessarily impose some restrictions on traffic. Narrow roadways are a menace and necessary restrictions should be reduced to the minimum practically attainable.

The roadway width should be based on the number of lanes of traffic for which provision is to be made and should be a multiple of the width required for one lane. To provide a width of roadway which is not an exact multiple of the width of a traffic lane is not economical, since the portion of the width in excess of that necessary for a certain number of whole lanes adds to the cost of the structure without increasing its traffic capacity.

There is some difference of opinion as to the proper width which should be assumed for a traffic lane and there has been considerable discussion as to whether it should be taken as 9 ft. or 10 ft. In any opinion the correct figure to be used depends on the purpose for which the assumption is made. A width of 9 ft. is undoubtedly sufficient for the passage of one line of vehicles and, therefore, for the determination of design loads, the width of 9 ft. should be assumed. Otherwise we will have 18 ft. roadway bridges designed for one line of traffic when actually they will carry two. But a width of 9 ft. is somewhat narrower than is desirable from the standpoint of safety and usually will tend to slow up traffic. Therefore it is most desirable that the actual width of roadway as constructed should be based on the 10-foot traffic lane, thus providing greater safety for fast traffic and reducing the tendency toward traffic congestion.

It may be said that roadway widths for bridges on main highways should be at least sufficient to provide for two lines of traffic. This means that the clear width of roadway must be at least 18 ft. and, for the reasons already stated, preferably should be not less than 20 ft. Furthermore, it may be said that, on paved roads, the distance betweeen bridge curbs should be at least as great as the width of the pavement and preferably should be somewhat greater. Otherwise traffic may be somewhat restricted, since a vehicle will not usually travel as close to a curb as it will to the edge of a pavement.

*Bridge Approaches*

Intimately connected with the width of the roadway on the bridge itself is the proper treatment of the approaches. Too often the presence of a bridge structure is indicated to the approaching driver only by unsightly, square-ended bridge rails looming up ahead and located well in toward the center of the highway, the approach fill being narrowed to meet the narrow roadway on the bridge. This indication of a restricted roadway without adequate approach protection is, unhappily, not always apparent at night. Such structures are not only an eyesore architecturally but are an actual menace to traffic. The shoulders of the narrow approach are difficult to maintain at the end of the bridge and if not maintained add still more to the danger to traffic. They may be widened by means of rip-rap and should be protected by guard rails converging toward the ends of the bridge. On new structures this condition may be avoided by proper design.

For obvious reasons, the bridge approach should be on a tangent or a very easy curve and sharp curves should be avoided. An adequate width of approach may be provided by building the abutment wing walls with horizontal tops for

a portion of their length, the horizontal portion being of such length that the approach fill may be maintained at full width to the end of the bridge. The wide approach fill provides for easier maintenance of shoulders and increases the safety of vehicles. In connection with the wide approaches, flaring rails at the ends of the structure give it an improved and finished appearance, increase its visibility to approaching drivers and serve to prevent vehicles from going over the wings. These flaring rails should extend to the shoulder of the fill or be supplemented by substantial guard rails.

*Bridge Floors*

Floors of concrete bridges will, of course, be of concrete. Floors for steel bridges may be of either wood or concrete. The determination of which material shall be used depends upon first cost and maintenance charges. The use of a wood floor will usually result in a somewhat lower first cost, both in the floor itself and, due to its low weight, in the supporting structure. But the maintenance cost is high, both on account of decay and on account of traffic wear. Decay may be partially overcome by preservative treatment and protection from the wear of traffic may be afforded by some sort of wearing surface. Both preservative treatment and wearing surface are expensive and tend to eliminate much of the apparent advantage in first cost.

We have many thousands of wood-floored steel bridges which are still serviceable but which are too light to carry anything but the wood floors for which they were designed. Increased traffic has made the maintenance of these floors very expensive and they must be maintained if the bridges are to be continued in service. A very satisfactory method of handling this maintenance problem is the use of laminated or strip floors of 2x4's 2x6's laid on edge and spiked together, and protected from wear by a carpet coat of tar or asphalt mixed with gravel or stone chips. This provides a serviceable floor and one which increases the rigidity of light structures.

But this situation should be avoided in future construction by making fixed steel bridges capable of carrying a concrete floor, even though it is intended to construct them in the first place with wood floors.

*Wearing Surfaces*

The bridge floor has two distinct functions to perform; it must be capable of carrying traffic loads and of resisting traffic wear. It is not desirable to subject to wear that portion of the floor upon which we depend for structural strength and, therefore, concrete bridge floors should be protected by a wearing surface or pavement. It will then be necessary to construct the floor only once, when the bridge is built. The pavement, which is subject to the destructive effect of traffic, can be maintained and renewed as required.

Concrete wearing surfaces for bridge floors are of two types, those placed monolithically with the concrete sub-floors are of two types, those placed monolithically with the concrete sub-floor and those placed separately. The separately placed wearing surfaces are to be preferred they furnish a definite line of demarcation between the wearing surface and sub-floor and thus provide effectively for maintenance and renewal.

In general, it is desirable that the bridge pavement be of the same type as the pavement of the adjacent highway. Of the wearing surfaces other than concrete, brick and asphaltic concrete find their greatest use when the highway paving is of one of these materials. Asphalt blocks are well suited for floors upon which an asphalt surface is desired but where the size of the job is not sufficient to make the use of a paving plant economical.

In case a bridge is located on an unpaved road upon which traffic is not sufficiently heavy at the time of construction to make a wearing surface of immediate necessity, the pavement may be omitted temporarily and placed later, when needed for protection or when the highway is paved. In the latter case it may be included in the regular paving program. In all such cases it is desirable that some additional thickness of floor be provided as a temporary monolithic wearing surface and it is essential that provision be made in design for the weight of the future pavement. The proper allowance to be made for the weight of future paving will depend, of course, on the type which is anticipated. It should never be less than 25 lbs. per sq. ft., which will permit the use of a 2-in. bituminous surfacing, and if concrete or brick is to be used it should be at least 50 lbs. per sq. ft.

For bridge pavements the requirements governing quality of materials, care in construction and curing, and accuracy of finish should be, in all respects,

at least equal to the corresponding requirements for the highway pavement.

*Junction of Bridge with Highway*

Theoretically, the junction of the bridge floor with the adjacent highway should be smooth and even and should have as good riding qualities as any other portion of the road. Actually this condition is difficult of attainment due to the settlement of approach fills and the necessity of providing expansion joints at the ends of structures. The design of expansion joints which will perform their function without introducing objectionable features in the roadway surface is a difficult matter. Innumerable types of joints have been used but the ideal joint is yet to be devised.

The settlement of approach fills introduces a complication which is particularly difficult to overcome on unsufaced roads or those surfaced with a non-rigid type of pavement. In these cases only the most careful maintenance will prevent objectionable and dangerous humps at the ends of bridge structures. When the highway paving is of concrete, the difficulty has been overcome in many instances by bridging, with the pavement itself, that portion of the fill adjacent to the structure. The end of the pavement is supported on the abutment back wall and is reinforced to act as a slab for a distance of from 10 to 20 ft. from the abutment. If appreciable settlement does occur when this construction is used, it will not result in a dangerous hump.

In some instances, serious damage has been done to bridge structures by the creeping of concrete pavements. When this action takes place, there are introduced forces of greater magnitude than any bridge can be expected to withstand. To provide for this condition, diagonal expansion joints have been placed in pavements near bridges with the idea that any longitudinal movement of the pavement will force it to move transversely along these joints and thus prevent the enormous pressure from being transferred to the bridge. I do not know that any such installations have been in place long enough to demonstrate their effectiveness.

*Protection of Structures and Traffic*

Before the advent of high-speed motor traffic it was considered sufficient to provide for the safety of vehicles on structures. Now we must make not only this provision but also must protect our structures, particularly our truss spans, from traffic accidents.

It is only recently that the need for this protection has become apparent but now our bridges are being wrecked in ever increasing numbers, with consequent loss of life and property. Trusses are the most vulnerable and have been the chief victims of these accidents. Their adequate protection from injury or total destruction is a new problem for highway bridge engineers and a most important one.

The accidents which have occurred indicate that the structure must be afforded protection for its entire length, since spans have been wrecked by collisions with web members as well as with end posts. Two methods have been suggested as a means of affording this protection. The first of these is the use of skid beams such as are used on railway bridges; the second is the construction of curbs high enough to stop a truck. Both methods have their disadvantages. One which is common to both is that neither is very well adapted to use on existing structures. Another is that both will probably detract from the appearance of the structure.

The two principal requisites of any protection which may be furnished are, that it shall be supported independently of the truss members which it is to protect and that it shall be strong enough to stop a motor vehicle.

Of the two methods which have been suggested, it seems that protection by curbs offers the greater possibility of satisfactory development. But it is scarcely applicable to bridges not floored with concrete and can probably have little use on existing structures since it will usually result in a narrowing of the roadway unless provision for this detail has been made in the original design. The curb should be at least 15 ins. and preferably should be not less than 18 ins. high. Its inside face should be at least 12 ins. from the clearance line of the truss members. By flaring these curbs at the ends of the structure and extending them out onto the approach fill or pavement, the end posts may be protected from vehicles approaching the bridge.

In the case of existing structures, when it is not feasible to protect the web system, the ends of the bridge may be protected from approaching vehicles by massive masonry posts.

In addition to affording positive mechanical protection, any device which may serve to direct traffic and definitely to define the roadway and the traffic lanes will be of benefit. Marking traffic

lanes by painted lines on the roadway surface and painting railings a light color are effective. Any actual obstructions in the roadway, which may be designed to act as traffic guides, should be avoided.

From the humanitarian standpoint, the protection of traffic is more important than the protection of structures and we have altogether too many serious accidents due to the lack of this protection. Traffic protection is not so simple as it was in the days of light vehicles and low speeds and it is necessary to provide more adequate safeguards than have been furnished in the past. The protection of the bridge approach has already been mentioned. On truss bridges any adequate protection of the structure itself will safeguard traffic. On other bridges, particularly those of the deck type, substantial curbs and rails are necessary. Flimsy rails, which will not withstand great punishment before failure, have no place on modern bridges.

The bridge is an integral part of the highway. It must be capable of carrying the loads to which it may be subjected; it should restrict traffic as little as possible; its floor should have as good riding qualities as any other portion of the highway; it must afford safety to traffic and must itself be protected from accident.

The foregoing paper by Mr. Kelly was presented at the 1924 convention of the American Road Builders Association.

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## CLASSIFICATION AND CAUSES OF HIGHWAY TRAFFIC ACCIDENTS

*By N. M. Isabella, Assistant Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.*

The subject assigned is one that is very rapidly forcing its way to the foreground in the field highway transportation. Due to the rapid growth of this form of transportation, the subject of highway traffic accidents has not been given the attention that it properly deserves from those who, to some extent, hold the reins in this new and modern development. The subject is very broad and far-reaching in its scope, and only some of the "high spots" can be touched upon.

### *Motor Data*

Statistics show that in 1895 there were 300 automobiles registered in the United States; in 1902, 28,755; in 1922, 12,239,114; and in 1923, approximately 14,000,000. Of the private automobiles there are probably on the average at least five persons having access to each one and as about 12,500,000 of the total motor driven vehicles are credited to private cars, this would give a total of at least 62,500,000 people who have access to private automobiles. In addition to this there are about 80,000 taxicabs, buses, etc., that are used to transport people from one place to another over the public highways, many of whose patrons do not own cars themselves. It is also estimated that about 325,000 children rode to and from school in motor buses during 1923. These are astounding figures, but very clearly indicate the growing demand for this form of transportation. Twenty years ago one would have been considered a lunatic or a dreamer if he had ventured the prophecy that there would be 14,000,000 motor vehicles in operation on American streets and highways in 1923. However, the fact remains that they are with us and with them we have inherited some good and some evil things which affect the social, industrial and economic life of the American people. It is almost impossible to point out a comparable episode in the history of this or any other nation. One of the unfortunate things forced upon us by this marvelous growth in highway transportation is the highway traffic accident which has been pronouncing the death sentence to hundreds and thousands of people annually and which, up until a comparatively short time ago, has practically escaped the attention of the American public.

When we can favorably compare the volume of business done on the highway, both freight and passenger, with that of the railroads and other agents of transportation, we can readily see there are a great number of people involved in the operation. It is stated with authority that the total investment in highway transportation exceeds that of the railroads by a large amount and the tendencies are toward a greater increase for highway transportation. Motor cars carry annually six times as many passengers as the railroads. Motor trucks carry approximately as much freight as the railroads. Over 125,000 doctors use motor cars. Over 130,000 suburban home owners depend chiefly on motor transportation. It has been very clearly shown quite generally that transporting freight over short distances on the highway is a more economical operation than doing the same work over the railroads, and for this reason there is an increasing volume

of business done over highways each year. As President Harding said: "The motor car has become an indispensable instrument in our political, social and industrial life."

*Accident Statistics*

The United States Census Bureau has compiled figures from all available sources to show the percentage of deaths occurring through highway traffic accidents each year. Statistics from this Department show that in 1914 there were approximately 1,231 people killed on the highways and streets. In 1923 the total reached approximately 15,000 killed and 1,700,000 injured. In 1917 there were approximately nine deaths to every 100,000 population. In 1921 there were 11.5 deaths to every 100,000 population. In 1922 there were 12.5 deaths to every 100,000 population. The figures are not complete for 1923 but indications point to a slight increase over that of 1922, or approximately 13.6 deaths to every 100,000 population. During 1923 every time the clock tolled off 28 minutes a life was taken on the highway, and every time the clock tolled off 2.5 minutes, some person was injured on the highway, and in many cases fatally.

The following table gives some very interesting figures on auto fatalities during the past seven years:

| Year | Motor Vehicle Registration | No. Motor Vehicles Per 1,000 Population | Total No. Auto Deaths | No. Deaths Per 100,000 Population | No. of Deaths Per 10,000 Motor Vehicles |
|---|---|---|---|---|---|
| 1917 | 5,104,321 | 48 | 9,184 | 8.87 | 19.0 |
| 1918 | 6,146,617 | 59 | 9,672 | 9.19 | 16.0 |
| 1919 | 7,530,105 | 71 | 9,827 | 9.36 | 13.0 |
| 1920 | 9,177,129 | 87 | 11,358 | 10.4 | 12.3 |
| 1921 | 10,464,005 | 99 | 12,500 | 11.5 | 11.9 |
| 1922 | 12,239,114 | 115 | 14,000 | 12.5 | 11.4 |
| 1923* | 14,000,000 | 127 | 15,000 | 13.4 | 10.7 |

*Approximate.

These figures should serve to point out the necessity for making a very thorough study and survey of the accidents occurring on the highways and how we, as engineers and road builders, can take steps to prevent, to a great extent, such accidents.

*Classification of Accidents*

Highway traffic accidents may be classified under two general heads: (1) The unavoidable accident, and (2) the avoidable or preventable accident. These two general classes can very easily be subdivided into the following: Under the first we would class those accidents which are the outcome of something which cannot be foreseen and protected against such as defective car mechanism or some feature which is beyond the reasonable control of the car operator. In other words, those accidents which happen regardless of what precautions have been taken by the drivers. Under the second class would be classified those accidents which, if proper precautions were observed by all parties concerned, could be prevented, such as reckless driving, including speeding, passing other cars on narrow roads, driving while intoxicated, racing, glaring headlights, pedestrians walking on heavily travelled highways, improper design and construction of roadways and roadway structures, bad alignment, insufficient protection on high and steep embankments, insufficient advance warnings of barricades or obstacles in the highway, and those due to poor and unsystematic maintenance of the highway.

The speaker is somewhat familiar with conditions in the Central West and especially in Wisconsin, where we have made accident surveys for the past few years to ascertain the causes of these accidents. Figures compiled in Wisconsin are for accidents which have occurred on the State Trunk Highways. This mileage comprises approximately 10% of the total rural mileage in the state and from traffic counts taken, it is estimated that approximately 65 to 70% of all the highway traffic is on this system. Reports of accidents also show that from 75 to 80% of the total accidents occur on this System, due largely to the concentration of traffic. The accompanying table shows a record of the State Trunk Highway accidents in Wisconsin during 1922 and 1923, and their causes. These figures were compiled from regular reports sent in by the State Trunk Highway patrolmen and other highway employees. Accidents occurring while the patrolmen were off duty were covered by news clippings sent to the Highway Department daily. When the patrolman is hired he is supplied with a number of blanks and stamped envelopes, and as soon as an accident occurs on his section he fills in the report and sends it in to the State Highway Department.

1922 AND 1923 ACCIDENTS IN WISCONSIN

| | 1922 and 1923 | Percent of Total |
|---|---|---|
| Total number of accidents | 2,981 | ..... |
| Number of people involved | 10,258 | ..... |
| Number of people killed | 267 | ..... |
| Number of people seriously injured | 794 | ..... |
| Number of people slightly injured | 2,506 | ..... |
| Accidents occurring on straight road | 2,044 | 68.6 |
| Accidents occurring at curves and corners | 479 | 16.0 |
| Accidents occurring at railroad crossings | 179 | 6.0 |
| Accidents occurring at cross roads | 138 | 4.6 |
| Accidents occurring on hills | 34 | 1.2 |
| Accidents occurring at miscellaneous places | 107 | 3.6 |
| Accidents due to reckless driving | 1,628 | 54.9 |
| Accidents due to improper or no lights | 218 | 7.2 |
| Accidents due to broken car mechanism | 151 | 5.0 |
| Accidents due to intoxicated drivers | 154 | 5.1 |
| Accidents due to weather conditions | 167 | 5.6 |
| Accidents due to car on wrong side of road | 74 | 2.5 |
| Accidents due to narrow bridges and culverts | 53 | 1.7 |
| Accidents due to miscellaneous causes | 536 | 18.0 |

*An Analysis of Accidents*

At first glance, it would seem out of reason that most of the accidents should occur on straight roads, but when one considers that the great majority of highway mileage is on straight roads, it is not so difficult to understand. There is also the fact that more drivers try to pass other cars on straight stretches than on any other part of the road. Reports show that the great majority of straight road accidents are due to one car trying to pass another. It is often stated by railroad officials that the straight road is more dangerous than the railroad crossing. This, of course, is not true. Considering the 1922 and 1923 accidents, we have a total of 2,981, 179 of which occurred at railroad crossings. Reports show that there was one death or serious injury to every 1.26 accidents occurring on railroad crossings and one death or serious injury to every 2.8 accidents occurring at other places on highways. In other words, the element of danger on the railroad crossings is at least twice as great as that on other parts of the highway. When we consider that the railroad grade crossings cover only a total of 3.28 miles of the 7,500 mile State Trunk Highway System, the ratios of accidents on grade crossings to equal distances on other parts of the State Trunk Highway System for 1922 were as follows: For all accidents, 148 times as numerous. Serious accidents, 314 times as numerous. Fatal accidents, 250 times as numerous. In 1923: For all accidents, 87 times as numerous. For serious accidents, 28 times as numerous. For fatal accidents, 407 times as numerous. The speaker, in giving these figures, is not attempting to justify the accidents occurring at places other than railroad crossings, but is bringing this out to show the necessity for grade separation on many of the crossings. The table also shows that the great majority of accidents are due to reckless or careless driving. There are many cases listed under "Reckless Driving," however, which are probably due to inexperienced drivers. Each year furnishes its crop of new drivers. Altogether too many of these do their practicing on the main highways where traffic is congested, instead of taking some unimportant highway. Looking over the list of different causes, one can readily see that the great majority of smash-ups could have been avoided if proper precautions had been exercised. Figures on traffc accidents in other states which have come to the speaker's attention indicate that the above percentages are fairly uniform.

*Most Accidents Are Preventable*

By examining these figures, one can clearly see that the great majority of accidents are due to some cause which can be prevented. It is surprising to note the small percentage of accidents that are actually due to improper construction of the roadway or to causes wherein the engineer or highway builder is directly responsible.

In probably too many instances the highway engineer and road builder are blamed for the accident when it really is the fault of the driver. From figures just given, it is quite evident that about 60% of highway traffic accidents are directly due to reckless driving. The other 40% are scattered over several different causes, of which a small share is charged to the road builder and engineer. However, if we can cut down even this small percentage we will be doing a meritorious work.

Due to the rapid growth of the motor vehicle industry, the demand for more and better highways has been so great during the past ten years that the engineer's time and attention has been devoted largely to planning and building

these highways. Even with the rapid strides made in highway building, it has been impossible to keep pace with the adequate needs of the motor vehicle. The manufacturer of the motor vehicle has been kept busy supplying the increasing demands for his product and has probably given insufficient time to the matter of highway traffic accidents. Highway transportation and road building are today considered as major operations, there being spent annually at the present time about eight hundred million to one billion dollars in the construction and maintenance of highways and about six billion dollars are involved in highway transportation.

If we study the history of railroad transportation, we find that during the last two decades some very effective improvements have been made along the lines of safety measures and development of accident preventing devices. Also in the education of their employees to the seriousness of safety first precautions. Now that the transportation over the highways exceeds the volume of business done by the railroads, is it not logical for those who are directly or indirectly connected with highways and highway transportation to consider very seriously the matter of accident prevention? To those planning and building highways and highway structures falls the task of building better and safer highways, to remove the danger producing element; and to plan adequately for the future development of highway traffic. Upon the user of the highways falls the responsibility of making the best use of existing conditions and of fostering the principles of safe and sane driving.

*Uniform Traffic Regulations*

Uniform traffic laws in all states would have a very beneficial effect. These must be reasonable and enforceable. As it is now, we have just about as many different sets of traffic laws as there are states. It is hardly fair to expect that the motorist can familiarize himself with the traffic laws of all the different states. The fact that the motorist does not know that laws in many cases has been responsible for many of the accidents.

*Enforcement of Traffic Regulations*

Much of the irresponsible and reckless driving can be eliminated by compelling observance of the speed laws and traffic regulations, through an adequate patrol force. At the present time this is not done in many of the states, but several are waking up to the fact that some real enforcement is necessary. Some of the states now employ traffic police to enforce the speed laws. In Wisconsin a law passed by the last legislature gives county highway officials power to recommend to the sheriff for appointment as Special Deputy Sheriffs men already in the employ of the county in other capacities. In most cases the men appointed are patrolmen, as they are constantly on the road. Those appointed have all the authority of deputy sheriffs in matters of highway law enforcement only. It is too early to predict what effect this will have on the motorist, but it is believed that it will have a great tendency to cut down the amount of reckless and irresponsible driving. The traveling public, being aware that the highways are under strict surveillance at all times, will accustom themselves to this fact, and the result will be that all drivers will gradually learn to drive more carefully and at a lower rate of speed.

*Uniform System of Warning and Caution Signs*

Uniform system of warning and caution signs will also do their share. The Mississippi Valley Highway Association, which comprises the states of Minnesota, Iowa, Illinois, Michigan, Ohio, Indiana, Wisconsin, Missouri, Kansas, North Dakota, South Dakota, Nebraska and Kentucky, has already adopted a uniform system of warning signs and from all indications the signs are working out very satisfactorily where they have already been placed in the field. The idea of using a shape sign to indicate the hazard originated with Mr. J. T. Donaghey, Maintenance Engineer of the Wisconsin Highway Commission, and making use of this idea the above named Association adopted a system of caution and warning signs that are simple but very effective. The square shape caution sign warns of a hazard adjacent to but not of the road, for example, a school, church, etc. The diamond shaped "slow" sign, warns of a hazard or condition of the road; for example, a curve, hill, new grading, etc. The circular sign indicates a railroad crossing. The last sign through legislative enactment had previously been made standard in several states. The octagonal sign is used for a "stop" sign. If the driver is warned of a sharp curve or steep hill, the sign will carry the word "Curve" or "Hill," as the case may be. There is also a rectangular sign used in Wisconsin which warns the driver of a turn. These signs are placed well in advance of the danger or caution point, so that the driver can get his car under

full control before coming to the point of hazard. It will be but a very short time before the users of the highway will learn what each shape stands for and they will drive accordingly. It is believed that if the driver is warned of the danger he is approaching better cooperation will be secured than if he were told by the sign what to do without knowing what the danger is. In other words, a driver would be more apt to pay attention to a sign carrying the words "Steep Grade" than he would to one at the same place carrying the words "Shift Gears." The driver in most cases would use his own judgment in shifting gears as all cars are not alike. It is sufficient to tell him that there is a "Steep Hill" a short distance ahead and then let him use his own judgment about the shifting of gears.

Others states will do well to fall in line and adopt this system of warning signs. The sooner a system of warning signs is standardized, the country over. the sooner will there be a noticeable decrease in highway traffic accidents.

It is believed that the time has come when practically all states are in accord with the fact that if the traveling public is to be properly served that the highway must be systematically maintained. In too many cases has the driver suddenly left a well maintained road in one county or state only to plunge into a sea of mud or impassable quagmire after crossing the line. There must be better cooperation along this line both inter-county and inter-state.

The teaching of safety measures in the schools will help build up a spirit in the growing generations which will have its good effect in the future. This is being done in many cities now and should become universal.

In conclusion, it may be stated that, while there are many things that contribute to the accidents which occur on the highways, if all concerned would exercise the utmost precautions in the using of the highways there would be a noticeable decrease in the number of accidents. If the highway builder and engineer, through his activities, does his share toward decreasing the number he will have set the example for the rest to follow. The accidents which are caused by sheer negligence of the drivers, of course, will have to be lessened by the drivers themselves. The following simple code, if uniformly observed, would materially reduce accidents:

*Accident Reduction Code*

1. Keep to the right.
2. Give the vehicle passing you one-half the road which is the consideration you are entitled to receive yourself.
3. At intersections, give the vehicle on your right the right of way.
4. When you park your car, park it where it will not obstruct or impede traffic.
5. Above all, keep your car under control, drive reasonably and cautiously—particularly at curves, hills, narrow places in the road, etc.
6. There are at least signs at all railroad grade crossings. When you approach one, be sure that you are proceeding safely. "Stop, Look and Listen." Take no chances. Many grade crossing accidents have occurred when the driver saw the train approaching and felt sure that he could get across in time, but his engine stalled on the crossing.
7. If you are an inexperienced driver. avoid heavy traffic; get your experience by driving where there is least chance of injuring yourself or others. Remember, when you drive, that an accident endangers not only yourself but everybody in the car. Many accidents occur because of reckless driving—that is, speeding; and all accidents, whether avoidable or unavoidable, are aggravated by speed.

It is suggested further to curb highway accidents, that the courts be less lenient than in the past in fining and imposing sentences on violators. In the past intoxicated drivers, careless drivers and others who have contributed to the large number of deaths occurring on the highways have escaped heavy sentences due to the leniency of the courts throughout the different states. A very decided change for heavier penalties for these offenses will no doubt reduce to great extent the number of accidents occurring on the highways. Engineers, road builders, manufacturers, and, in fact, all who use the highway, should co-operate in every way to bring about a betterment in the present conditions existing on the highways.

The foregoing paper by Mr. Isabella was presented at the 1924 meeting of the American Road Builders Association.

# PNEUMATIC EQUIPMENT FOR BREAKING ICE AND FROZEN GROUND

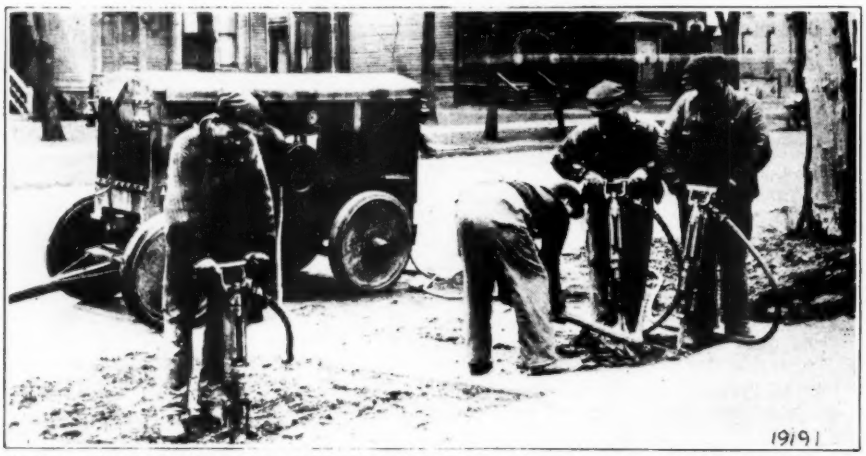
*By V. H. Van Diver, Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

Considerable trouble is experienced in a good many cities because of ice forming in the gutters and later causing the streets to be flooded. Years ago, perhaps, when general contracting stood still during the winter months and labor, as a result, was cheap and plentiful, it may have been possible to put enough men to work to keep the ice broken up and the evil remedied. But today, when labor is just as scarce during the winter months as it is in the summer and just as expensive, it is only with the aid of modern labor-aiding devices that any city can attempt to break up great quantities of ice along its streets, or to solve other winter problems economically, such as breaking frozen ground, testing for gas leaks, etc.

A portable air compressor, paving breakers, "Jackhamers," clay diggers, and various other pneumatic tools, are necessities of the modern progressive city. In season this equipment, with its small complement of men, is used to carry out street, water or gas main, and sewer improvements, repairs, extensions, and, in fact, any number of jobs that confront the important departments. And, it is notable that with these ingenious devices a crew of men can do from 5 to 20 times as much work as it would be possible for the same crew to do by the best methods prevalent a few years ago.

BREAKING ICE ON BUFFALO, N. Y., STREET WITH PNEUMATIC PAVING BREAKER EQUIPPED WITH SPECIAL BIT.

Out of season, during the winter months, this equipment need not lie idly in storage. The accompanying pho-




BREAKING FROZEN GROUND FOR DETROIT PUBLIC LIGHTING COMMISSION WITH PAVING BREAKERS AND PORTABLE COMPRESSOR.

tographs illustrate some of the ways in which it may be kept at work.

The city of Buffalo, by adapting special bits to their paving breakers and clay diggers, found the solution to their problem of freeing their streets of ice.

The Public Lighting Commission of the City of Detroit, by using an Ingersoll-Rand 8x8 Type Fourteen Portable Compressor to operate paving breakers for breaking frozen ground, soft loam, after which a trenching machine could be used, was able to carry on some necessary extensions without interruption.

TESTING FOR GAS LEAKS THROUGH PAVEMENT AND FROZEN GROUND AT SCRANTON, PA.

This Work Was Previously Done With Sledges and Jumper Steel as Shown in Hands of Man at the Left. Sometimes this Required Several Hours to Put Down One Hole. With the Pneumatic Equipment Shown the Hole Was Put Down in Two Minutes.

Employes of the Scranton Gas & Water Company, in testing for gas leaks through pavement and frozen ground employed a DCR-23 "Jackhamer," using ordinary ⅞-in hollow hexagon steel with a large four-point bit. Testing for gas leaks had always been a tedious task when it was necessary to rely on a jumper steel and sledges. Oftentimes—even where the leaks were costly—it had taken several hours at least to put down a single test hole by this hand method, but with the air operated "Jackhamer" operated by one man this time was cut to a matter of but ten minutes.

Every day new uses are being discovered for existing pneumatic labor aiding devices and every day new devices are being developed. These, together with a portable air compressor, enable progressive men to face the ever increasing shortage of labor fearlessly.

## PAINTS AND PAINTING FOR STRUCTURAL STEEL

*By H. L. Maxwell, Department of Chemistry, Iowa State College, Ames, Iowa*

(Editor's Note: The following matter is an abstract of a paper by Mr. Maxwell before the recent annual meeting of the Iowa Engineering Society.)

The adequate protection of steel structures is no less important than the careful selection of members and the building of the structures. Steel bridges and buildings everywhere are constantly attacked by agencies of corrosion, but, if they are protected by a continuous film of paint, their period of usefulness may be greatly prolonged.

### *Three Requirements for Paint*

When an engineer selects a paint for a structural steel, he should make three requirements of the material he uses.

Will this paint protect and preserve the steel? In order to protect steel, a paint must have nothing among its ingredients that will react with the metal surface. An acid oil or pigment will corrode the metal surface and cause a thin scale of rust to form and extend in all directions

until a large scale is loosened and drops off.

This corrosion in spots is frequently noticed on black paint where tar or an inferior asphaltum has been used. These are not good paint materials for steel for the reason that they usually contain phenols and other decomposition products which are acid in reaction. The acid attacks the metal, forming a salt which hydrolizes, setting the acid free to become active again. The tar paint criticised above should not be confused with graphite, a natural occurring black mineral which, when ground and blended with oil, makes a very serviceable paint for bridges and steel surfaces in general.

Lead sulphate, $PbSO_4$, is a material which may be classed as an acid pigment. This is due to the fact that the material, though nearly insoluble, will hydrolize to give free acid. Of course the quantity produced is small, but it is there nevertheless.

The basic lead sulphite, $PbSO_4$, $PbO$, as found in sublimed blue lead, does not react like the normal lead sulphate and is therefore a very satisfactory pigment.

On the other hand, basic pigments like $CaCO_3$ react with the oil, forming calcium soaps, which make the paint film more permeable to water.

Lead monoxide is another material which reacts with linseed oil. When stirred together they form a hard mass. Red lead of high purity, one which contains less than 3 or 4 per cent of litharge, has proven to be one of the most valuable steel paints. It dries smoothly to a dense, tough film, which gives maximum protection. Too often, however, commercial red lead contains a large proportion of lead monoxide or litharge and a viscous, stringy mass results. Such a red lead paint is difficult to apply; it dries to a hard, brittle film and is easily chipped where it is exposed to wear or handling. However, where it is protected from mechanical wear, as in the protection of reinforcing steel, or in coating underground water pipes, it serves very well, it being more resistant to the action of water than the more highly oxidized and hence more expensive red leads.

For general painting or exposed steel structures it has been definitely shown that a highly oxidized red lead is preferable to one containing more than 5 per cent of the unchanged monoxide. Such a paint costs a little more, but it goes farther, is more easily applied and gives a much better surface for subsequent coats. The dried film is much more pliable and elastic and hence more durable than a paint film prepared from red lead containing more of the PbO.

It would not be an economy of time to discuss in detail the merits of the various pigments. The 40 or 50 single pigments have been blended and proportioned by paint manufacturers until there are on sale an almost limitless range of combinations, many of which have no excuse for being on the market.

*Application of the Paint*

The second part of this discussion deals with the application of the paint.

The metal surface must be dry and free from grease, dust, dirt, rust, mill scale or loose remnants of a former paint coat. Particular attention should be paid to the bolt heads and the riveted joints, for these are the causes of the most failures in paint jobs. Paint is viscous and particularly if the weather is cool, the oil will not reach the clean metal in these less accessible places. The result is that water is drawn through the paint film and corrosion of the joint begins anew. Rivet heads and joints should be painted with the tip of the brush well charged with paint. Sometimes a thrusting movement of the brush is necessary to deliver sufficient paint into the seams and crevices. The brush should then be worked free from paint on the adjacent flat surface and then be used to take up the excess around the joints and rivet heads. This method should be used particularly on the first coat.

In general where two coats are to be applied there is an objection to using paint of widely different compositions. The first coat, of course, may be a little thinner, but it should give a film of approximately the same density, porosity and tensile strength as the film that is to be used over it. For instance, it is not advisable to use red lead over blue lead or blue lead over graphite. However, graphite over red lead or blue lead over white lead, have been found to give uniformly good service.

*Color*

It is often advisable to use the same paint for the second as for the first coat. This makes it difficult to inspect the second coat, there being no difference in color. In addition, it has been shown that men accomplish more when they are painting over a surface of a slightly different color. These conditions have given

rise to the practice of tinting the first coat. The first coat of red lead or sublimed blue lead may be tinted with a few ounces of carbon black.

The third point under discussion deals with fading or loss of color. One of the essential qualities in a paint is that it should hold its color. There are certain factors that must be taken into account in selecting a color for a particular use. For instance, white lead cannot be used on a bridge or guard rail near a point where a sanitary sewer empties into the stream; this is because of the fact that the hydrogen sulphide rising from the water would turn the white lead pigment to a black sulphide. A graphite paint would be much more serviceable in this instance.

Red lead, sublimed blue lead and most mixed paints fade out to a lighter shade because the colored lead compounds undergo chemical changes, becoming either carbonate or sulphate, both of which are white. Also, the breaking down and decomposition of the dried vehicle tends to leave the pigment particles exposed. This increases their power to reflect light, and hence the weathered paint appears lighter in shade than the newly painted surface. The fading of paint is, in most cases, probably due to the combined effect of the two agencies mentioned.

The fading of red lead may be overcome by adding to the pigment a small amount of permanent red. It is usually added in the form of a lake, which is an organic dye precipitated on an aluminum hydroxide base. The permanency of color of sublimed blue lead may be improved by the addition of a small amount of pure carbon black. This compensates for the loss of color due to the oxidation of the lead sulphide and also to broken oil film.

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# OILED EARTH ROADS IN ILLINOIS

*By J. H. Reed, County Superintendent of Highways, Henry County, Cambridge, Ill.*

Oiled roads are comparatively new in Illinois and may be considered as still in the experimental or trial stage. Some 12 years ago road oil was in use in a number of places on village streets and country roads on a small scale. Great improvements resulted and the demand for oiled roads has increased until in 1923 not less than 40,000,000 gals. of oil were used on some 10,000 miles of roads and streets.

*The Place of the Oiled Earth Road*

The writer does not regard the oiled road as a substitute for the hard road but believes our main roads should be paved as rapidly as sound economics permit, and hopes to see the proposed $100,000,000 State Bond Issue for hard roads voted as a means to that end. However road oiling has attained such proportions and the improvements made thereby have been so great that he believes the process merits careful consideration and investigation as a means of improving secondary roads, and he proposes to indicate the directions he thinks such investigations might well take and to outline what is being done in Illinois along these and similar lines by road officials and others interested.

*Fundamentals*

The methods at present in use for constructing and maintaining oiled roads should be understood, the results obtained carefully noted and costs accurately ascertained. The fundamental nature of the oil and the nature of the compounds, mixtures or emulsions formed when oil is applied on the road should be studied, for it would seem that such studies should lead to a better understanding of the properties, or qualities, to be striven for in the manufacture of road oil and of the best methods of using the product. The effects of different soils and slight climatic differences are to be taken into consideration, and in as far as may be, the limitations and possibilities of the process should be determined.

*Preparing the Road*

The usual methods of preparing the road and applying the oil are of common observation. The road is graded as early in the spring as the condition of the ground will permit. It is left open to traffic and is frequently dragged or gone over with some form of maintainer until the oil is applied, the object being to have the road settled and as evenly packed and smooth as possible when the oil is put on. The cross section of an oiled road is important. A crown of 12 ins. in a width of 24 ft. has been found satisfactory on a road with considerable traffic.

*Pressure Oilers*

In Illinois road oil is usually heated and applied with pressure oilers mounted on motor trucks, though light oils are sometimes successfully applied without heating. The most common form of distributing truck, or spreader, is that in which a roatry pump, driven by the

truck motor, forces the oil onto the road through spray nozzles. In this way the oil is applied very uniformly. On country roads different quantities of oil are used, 2,500 to 4,000 gals. per mile, and ½ to ¾ gal. per sq. yd. being common figures, with a tendency toward the use of more oil. The cost varies with the price of oil and the distance hauled, but in 1923 was often 6½ to 7 cts. per gal. including oil, freight and spreading. Maintenance is carried on, or attempted, with road drags, blade maintainers and similar apparatus.

*Used in Central Illinois*

The greater part of the road oil used in Illinois is applied on the earth roads of the central part of the State, little being used in those northern counties where gravel or rock is available for road building, and little going south of the black soil belt. Within Central Illinois great improvement in roads has resulted from the use of oil although the degree of success attained has not always been everywhere the same.

*Performance of Oiled Roads*

The oiled roads are at nearly all times better than the unoiled. Except where the soil is light and except during long periods of hot dry weather, the dust is kept down. Summer rains have little detrimental effect on an oiled road, and in the fall, when rains are frequent and evaporation is slow the difference is often such that reports issued by automobile clubs on road conditions frequently contain such notes as: "Unoiled roads very muddy, Oiled roads good, 90% main roads oiled." "State Aid oiled earth roads in good condition despite rains of last few days." "These three are oiled and in good shape at all times."

In the spring oiled roads sometimes fail and oiling will not cure "seep holes" which occasionally appear at that time on account of water in the subgrade. On the other hand some counties report that oiled roads have carried a very considerable traffic uninterruptedly and satisfactorily throughout the entire year.

As pointing toward the limitations of oiling, it seems that oil does not increase the bearing power of the road above that of the compacted unoiled soil, nor does it form a mat, or oiled crust, or layer of earth mixed with oil, of sufficient strength, as a slab, to distribute wheel loads over any considerable area. At present its possibilities seem to be those which would follow the formation of a surface which will not become dusty and which will shed water.

VIEW OF AN EXPERIMENTAL OILED ROAD IN HENRY COUNTY, ILL., TAKEN DEC. 11, 1923.

*Study of the Process*

As to what is being done in a study of the process, outside of the actual oiling of roads undertaken by many townships and counties, it may be said that the University of Illinois, the Illinois Division of Highways, certain of the counties and many of the large oil producers and refiners are devoting a great deal of time and study to the subject, both in the laboratory and in the field.

*Experimental Roads*

Three experimental roads have been oiled, one at Urbana, by the University, under the charge of Professor W. M. Wilson, one near Rosemond, conducted by the State Division of Highways and Christian County jointly, and one near Cambridge, conducted by the State and Henry County. Mr. F. L. Sperry, assistant Engineer of Materials of the Division of Highways has been in imme-

diate charge of the two last named roads for the State. A number of the large oil companies have cooperated earnestly in this work, donating oil in some instances and assisting in every way possible through their engineers and chemists.

*The Experimental Road in Henry County*

A brief description of the experimental road in Henry County will indicate the scope of the work undertaken. The road chosen for the experiment is typical of the most heavily traveled country roads of that part of the State and throughout its length the soil is quite uniform. It is divided into 15 sections each 1,000 ft. long, and each section is oiled with a different kind or quantity of oil. On some sections the total quantity was all applied the same day, and on others the same total quantity was used but it was applied at two or three different times during the season.

The road oils available here are usually residuums resulting from the distillation of crude petroleum. In some instances a heavy residuum is "cut back" with a lighter oil and sometimes different residuums are blended. By different kinds of oil is meant distinct types, distinguished by the source, or field, supplying the crude from which the road oil is made or by the process of refining, and all the various types supplied commercially in Illinois have been used in these experiments.

The experiments in Henry County have been in progress during the past six months only and it is felt that definite conclusions as to the best kinds of oil for the purpose and the best methods of construction should not be drawn from these experiments before the road has at least gone through the trying conditions of spring, especially as the comparative condition of the several sections changes rapidly and continually. However, many interesting, and sometimes unsuspected, facts have been observed which appear to be factors in the success of an oiled road, and certain things seem fairly well established. For instance, it seems likely that ¾ gal. per sq. yd. is the minimum that can be depended on through the year and much better results have been obtained when the entire quantity was not applied all in the spring, but part was reserved until late in the summer.

It is planned to continue the experimental roads in 1924, with the work of the University, the Division of Highways and the counties concerned carefully coordinated. And it is the hope of those connected with the work that information will be obtained which, added to the experience accumulating in oiling, will lead to a determination of the proper field for this method of road improvement and to the economical construction, within that field, of good and dependable oiled roads.

The foregoing paper by Mr. Reed was presented at the recent annual meeting of the Illinois Society of Engineers, January, 1924.

## ROAD SALVAGING PROCEDURE IN WYOMING

The Salt Creek Highway, about 40 miles in length, extends from the city of Casper to the Salt Creek oil fields.

Originally this was wholly an earth road, but in 1918 and 1919 the first five miles were improved by the construction of a Portland cement concrete pavement 16 ft. in width. About equal portions were constructed in each year, the completion date being Sept. 1, 1919.

Subjected to extraordinary traffic, this pavement failed. At the end of 1922, after three years' use, large areas were

VIEW OF COMPLETED RESURFACING OF CASPER-SALT CREEK HIGHWAY IN WYOMING.
Warrenite-Bitulithic on Black Base Over Old Cement Concrete Road.

very badly shattered, and over practically the entire five miles the excessive cracking of the pavement foreshadowed complete destruction.

At first it was decided to reconstruct the pavement at those points where it had entirely failed, and where it was shattered. A careful study of conditions, however, indicated that such reconstruction would necessitate the rebuilding of fully half the original five miles of pavement. Thus, it was decided to recon-

struct only those areas which were ruined by the enormous loads of the type herewith illustrated, and then to lay sufficient dense mixed bituminous concrete mixture (commonly called "Black Base") over the entire road to provide the proper cross-section and slightly increase the crown, and then resurface the entire width of roadway with Warrenite-Bitulithic.

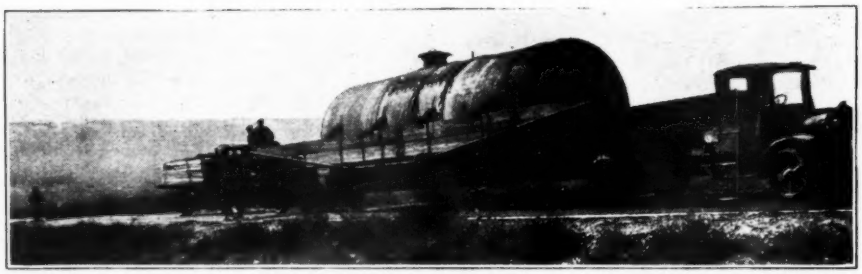
Specifications were drawn and tenders for the contract solicited. The award was made to the Warren Construction Company of Portland, Oregon, that Company, incidentally, having constructed the Warrenite-Bitulithic pavement on the same highway in 1920 for a distance of two miles, extending from the end of the cement concrete pavement to the city limits of Casper. The success of this pavement under very heavy traffic resulted in the decision of the officials to salvage the deteriorated cement concrete pavement with Warrenite-Bitulithic.

Portland cement concrete curbs were constructed along the edges of the old road to the depth of the concrete slab and to a height of 2 ins. above the old surface to form a containing support for the new bituminous concrete base and the 2 in. Warrenite-Bitulithic surface.

Work was begun July 1st on the construction of the cement concrete curbs and the reconstruction of the destroyed areas of the old road. All work on the contract was completed Oct. 28, 1923, three months after the work was started, although progress was at times delayed by weather and by non-deliveries of materials.

The large still shown herewith loaded upon the trucks weighs with the trucks upwards of 40 tons and is only one of 16 which were transported over this road from Casper to the Salt Creek oil fields during October. In 1922 one company alone, the Midwest Oil and Refining Co., sent 25,000 tons of freight over this road and up to Nov. 1, 1923, had transported 32,500 tons over it. This was in loads varying in weight from the minimum of 3½ tons up to the maximum of 40 tons represented by the stills above mentioned.

In addition to the above and the other heavy traffic to and from the oil fields, the Warrentite-Bitulithic pavement on the first two miles of the road bears the extremely heavy traffic from the Midwest Company's refinery, since it forms the only means of communication between the refinery and the city of Casper. Furthermore, it also forms a link in the Yellowstone Highway and carries the enormous number of touring automobiles which annually visit America's best known National Park, the Yellowstone.



CLASS OF LOADS THAT DESTROYED CASPER-SALT CREEK HIGHWAY IN WYOMING.

View of Still En Route from Casper to the Salt Creek Oil Fields. Combined Weight of Still and Trucks 40 Tons.

## ADVERTISING VALUE OF COMMUNITY RECREATION

*By Eugene T. Lies; Special Representative, Playground and Recreation Association of America, 21 N. La Salle St., Chicago, Ill.*

My task is not to set forth the technique of advertising a community through its recreation, but rather to portray the unique advertising value of the right kind of recreation program to any community which has it in operation.

Advertising a commodity is the process of making the world desire and buy that commodity, Advertising a community is intended first to make the town look good to its own inhabitants; the next, to make it look good to the folks outside. Getting the people at home to realize that they are living in a good town arouses their civic pride, loyalty, desire to participate in its affairs, and a greater willingness to make it their dwelling place from everlasting unto everlasting. Convince the people not yet within its borders that

they are depriving themselves of much that is worthwhile in life by not crossing the line and they are more likely to follow the call to come hither.

*Recreation a Necessity*

My contention is that one of the necessary good things in any modern community's resources without which it cannot hope to hold its own people is adequate recreation provision for young and old. My further contention is that the time is here when such provision can and should be a strong talking point in attempting "to sell" a town to business men, workers and their families who are still in that outer darkness. Why do I say this? It is because of the new and growing recognition that recreation is a necessity and not a luxury in modern life, that it is needed by young and old, that it aids youth to grow rightly to adulthood and adulthood to keep its youth, that it promotes health, morale, efficiency, character, personality, contentment and citizenship and that, therefore, it is as important in a city plan as are streets, water, sewerage arrangements and such other fundamentals. We are justified in saying that the town that does not work out and apply a program which will reach every human being in the community with wholesome, constructive recreation is woefully behind the times; indeed, that it has its head in the sand and is bound to come to grief while at the same time its neighbor city, alive to the realities of the situation, will reap another and better kind of harvest.

*Use and Misuse of Leisure*

In order to justify this view of the matter, let us consider some of the factors present in the life of our day. There is first the outstanding situation that America has larger leisure than ever before in its history, eight hours for work, eight hours for sleep and eight hours for doing what we will, which means for the whole of the United States something like 720,000,000 leisure hours per day for the 90,000,000 of our population over five years of age. The question is, what shall we do with these eight hours in which we can do something else? Misuse of leisure time spells destruction of health, morality and integrity. Trifling use of it spells mediocrity. Worthwhile use of it spells health, vitality, character, citizenship and joy. In the field of recreation, broadly conceived, we shall find a large part of the solution of the leisure time problem of today. Long ago, George Eliot said, "It is as important to organize the leisure of a nation as it is to organize its industry."

*Delinquency and Crime*

Another outstanding fact of our time, and especially in our country, is the extent of delinquency and crime. Somebody has said that we are the most lawless nation on the face of the earth, and then went on to prove it by citing that we have something like 300,000 professional criminals in the United States, that about 100,000 youngsters go through our courts on delinquency charges each year, that the total losses from robberies, thefts, confidence games and frauds of all kinds, run up to about three billions a year, that in a recent seven-year period 59,377 murders were committed, which is 9,050 more than the number of American soldiers killed in battle in the great war. Surely such startling figures must make us pause and wonder whether the business of dealing with crime consists wholly of putting on more police, establishing more courts, building more jails, reformatories and prisons, or whether there is not a little common sense in applying the old adage, "An ounce of prevention is worth a pound of cure."

*Most Criminals Are Young*

The latter query is especially pertinent when we realize that about 5 per cent of all incarcerated criminals are found to be not fifty, sixty and seventy years of age, but under twenty-five years of age, veritable youngsters, indicating clearly that present-day criminality is a problem of youth, youth gone wrong as a rule in quest of adventure, companionship, recreation, but misdirected or misguided, implying lax parenthood, lax communities, *laissez faire* communities, ignorant of their social responsibility toward their boys and girls.

What a mockery it is for any town to invite strangers to live within its gates when it light-heartedly permits conditions to prevail which cause a constant stream of young folks to move on through its courts, to the jails and prisons beyond. On the other hand, what a fine opportunity for that town which, through proper recreation provision, not only prevents this gruesome march with all its tragedy and tears, but contributes abounding joy to its young folks, to nail to its advertising mart the slogan, "We believe in healthy, happy youth in Xville."

Parenthetically, one may throw in the fact that our crime bill at present is something like one and one-quarter billion dollars per year, and that it is

estimated that 50 per cent of the delinquencies of youth can be prevented or cured through recreation. Here's a chance for an investment that will yield usurious interest.

*Effects of Dehumanized Industry*

The results of our modern automatic machine industry in the lives of millions who toil in factories are such as to form another great big reason for increasing community attention to the values inherent in all that we properly think of under the head of recreation. Psychologists are pointing out the deadening effects upon the spirit of workers from over-specialization and monotonous, continuous muscular processes. They say that the finer instincts of creation are getting no show at all in the man who has nothing to do during his daily eight hours of toil but to drop Bolt. No. 49 into its proper hole in the passing automobile going down the line to completion. They tell us that we cannot continue to choke fine instincts and expect to have fine men, that something is going to break and something is breaking in the life of the industrial worker today. Possibly part of his soreness, his restlessness, is due to this cause. If it is true that it is not possible within industry to change this situation then obviously something must be done outside of industry during spare hours to satisfy the deep longings of industrial workers who are fundamentally human beings if we would not have them become wholly unfit family men, neighbors and citizens of the republic. My contention is that constructive, rehabilitating, stimulating creative types of recreation are called for on a larger scale than ever before in our history to meet at least part of this need.

*Appalling Physical Disability Now*

Another fact: The draft examinations during the late war showed that something like a million and a half men, between the ages of 21 and 30 years, out of a little over four million were disqualified for service because of physical disabilities. Here were youths supposed to be in the most vigorous period of life found unfit under tests not especiaaly rigorous to serve their country in time of need. Authorities tell us that a very considerable proportion of these disabilities might have been prevented, or at least minimized, if these young men had had the advantage of plenty of physical training, athletics and sports during their distinctly formative years.

Another aspect of the physical side of the whole question lies in the fact that about 42,000,000 men and women gainfully employed in the United States lose on an average eight days annually from illness and other physical disabilities, or a total of 336,000,000 days—a tremendous social and economic liability which could certainly be reduced considerably by wise and adequate physical recreation. Then, too, only one-tenth of our 20,000,000 school children are at present receiving real physical education in the schools and yet 12,000,000 of them are said to have physical defects hindering their school progress.

We know that historically, the peoples who have gone in for athletics are the peoples who have gone farthest in real democracy. An athletic nation is rarely a militaristic nation. Athletics offer splendid outlets for exuberant spirits. South America has her revolutions; North America has her athletic contests.

*Relief of Nervous Strain*

Still another fact: The complexity, rush and strain of American life call for the establishment of every possible upbuilding, morale-forming and mellowing influence which can be incorporated in our community programs. There is a shockingly large population in our institutions for the mentally afflicted and the cost of caring for them is tremendous. The psychiatrists and alienists tell us we are living too fast and that we must slow down if we are not to expect a downright and widespread degenerative process to set in throughout our American life. Recreation of the right sort is a medicine for tired nerves and holds in check the flying off the handle propensities of the over-wrought while at the same time it enhances life.

*Recreation by Proxy*

It is apparent that the kind of recreation I am urging is the self-participating kind rather than the kind which so many people take—namely, by proxy and vicariously. Sitting on the sidelines and watching the other fellow play may offer us some excitement but it does not stretch our muscles. We have an overabundance of commercialized amusements. Indeed, together they form at this time nearly the largest industry in America, with more money invested in it and more money taken out as profits than in any other human endeavor; 12,000,000 of us go to the movies every day; 30,000 to 70,000 attend many a ball game; 45,000 to 80,000 attend the great

prize fights and so on. Of course, one does not say: "Thou shalt not go to the movie or the ball game" but rather, "Get into the game yourself, some kind of game, many kinds of games that call for exertion and self-expression that give satisfaction to deep creative impulses." The concrete means are playgrounds, athletic fields, community centers, community music, dramatic pageantry and art opportunities, etc. The result is achievement, vitality, music, art, social enrichment, better citizenship.

*Still Much to Be Done*

Now comes a vital consideration regarding this whole subject of recreation. It is that so many different groups of people are annually getting hold of the fundamental values of which we have been speaking and are increasingly concerned that there shall be larger provision for getting those values into the every-day life of all-age groups in every community in the country. The parent-teacher organizations, the women's clubs not only, but the employers, organized workers and the clergy, are getting a deeper and deeper insight into this whole field. Only recently the American Federation of Labor accepted a program of co-operation from the Playground and Recreation Association of America through which it is expected that trade unions will soon be doing more than they ever have before along recreation lines within their own ranks and will also be demanding larger recreation provision in communities. We are ready to help them in realizing these ends. As a matter of fact only 260 cities of 8,000 population and upward have all-the-year-round recreation systems, leaving still about 700 more which should have them. Hence there is still much to be done.

Another significant sign of the times is indicated in a statement by Professor Norman E. Richardson, head of the Religious Education Department of Northwestern University, in his new book "The Church at Play," namely, "It is largely through the proper use of leisure that the kingdom of God will be realized." This is a well-nigh sensational utterance especially when one realizes that it is uttered by a Methodist teacher in a Methodist institution, in a book put out by a Methodist publishing concern.

*Can We Afford It?*

Somebody asks, "Well, can the country afford the expense of establishing adequate recreation facilities for young and old?" My answer is another question: "Can a country which spent in a year for luxuries $22,700,000,000 spend a tiny fraction of that amount for this great thing?" As we have seen, the cost of not doing it overshadows by far the cost of doing it.

*A Program*

America has achieved mightily in the realm of industry and the transformation of raw materials into consumable products. The emphasis from now on must be upon the human element in our democracy. This needs to be greatly enriched and recreation is one of the important means of enrichment. To get from recreation, however, all that it has to offer either in the life of the individual or the community, calls for thought just as the placing, paving, and cleaning of streets call for thought. I argue for a plan, a program, an adequate program based upon community's conditions, its needs, and upon the experience of other communities where thought and planning have already brought their rich fruitage. Such a plan implies the participation of all organized groups together with the public officials of the town. It means permanent organization of some central body to be fact-finder- path-finder, clearing house, dynamo. The Playground and Recreation Association of America with its eighteen years' of experience is ready with its literature, counsel and field service to help communities realize such an ideal. It is doing so right now in scores of towns of various sizes around the country. It has found in each of such places that the leaders were quick to let the world know about this thing upon which they had entered because of the splendid results, economic and human. They were able to say through printer's ink and vocally that theirs was a community where life was valued at 100 per cent of its worth. They had set it up on a hill for men to see.

From all that has been said thus far, are we not justified in concluding that there is unique advertising value in a full-blown program of community recreation, because, first the absolute need of it is being increasingly recognized in our American life; second, the common people are increasingly demanding it; and third, the very nature of the subject matter of recreation lends itself to such joyous, magnetic, "come hither" treatment?

The town that can rightfully proclaim its possession of this great boon for all of its people, not only commends itself as being among the progressive com-

munities of the land but at the same time is automatically performing the social service of shaming backward communities into action.

The foregoing address by Mr. Lies was delivered before the recent annual meeting of the League of Nebraska Municipalities.

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## LIGHTING THE HUDSON RIVER VEHICULAR TUNNEL

One of the most ambitious engineering projects attempted in recent years is the building of the Hudson river vehicular tunnel, which will link New York to New Jersey in the most efficient way yet devised. Traffic between the two states is at all times very heavy, and because of New Jersey's popular resorts, week-ends and holidays bring a congestion of automobiles that is far beyond the capacity of the existing ferry service.

There will actually be two tunnels, one for east-bound and one for west-bound traffic. Each will be 29 ft. 6 ins. in diameter, and 9,250 ft. long. The roadways will be 20 ft. wide and have an overhead clearance of 13 ft. 6 ins. The rest of the space will be required for the ventilating system, which consists of air ducts at the top and bottom of each tunnel. Fresh air under compression will be forced into the lower duct and from there into the roadway itself through air flues and expansion chambers placed at intervals of 15 ft. along each side of the tunnel. This will force the vitiated air out through openings also at 15 ft. intervals into the top duct, whence it will be drawn out by large fans and discharged through the caissons at the ends of the tunnels.

The tunnels are being constructed from both ends, and will meet somewhere in the middle of the river. The calculations on the work are so accurate that when the tunnels meet they will not deviate half an inch. The tunnels are built in ring sections of fourteen cast-iron plates, each plate weighing a ton and a half. The excavating is done in shields, or movable heads, which are pushed forward 2½ ft. at a time by 30 hydraulic jacks. As the shield moves forward the rings are added one by one. When completed the tunnels will have a protective covering of broken stone, and at each entrance there will be a modern pier above the tunnel as it reaches the land, in order to avoid the possibility of a ship running into the tunnel where it comes up.

One of the most difficult problems in connection with building the tunnel has been proper illumination. The Illuminating Engineering Laboratory of the Westinghouse Lamp Company recently became interested in this problem and began a series of experiments to determine the best possible lighting system. In order to study all suitable systems of illumination under approximate operating conditions, an exact model of the tunnel on a scale of 1 in. to 1 ft. and 10 ft. long was constructed in the Bloomfield plant. Exact replicas of the proposed lighting units were installed in this model tunnel, furnishing an amount of light corresponding accurately to the desired illumination. The model tunnel is complete to the most minute detail, even the brass railing along the walk for pedestrians being provided.

It would seem at first glance that lighting the tunnels would be merely a matter of installing plenty of units, but that is not the case. It is necessary in the first place to eliminate all glare, so the units, 1 every 20 ft., were encased in metal boxes sunk into the concrete of the tunnel, and diffusing glass used to cover them. Next, the lights had to be so placed as to secure the greatest possible amount of reflected illumination from the walls and ceiling. Third, and most important, it is extremely necessary that all shadows between cars be eliminated in so far as possible, as sharp shadows would cause drivers to misjudge distances, which might result in accidents. As the new tunnel is expected to relieve the traffic congestion on the west side of New York, any accidents or tieups in the tunnel must be rigorously guarded against, and proper illumination will be an important factor in accomplishing this.

While the experiments on the illumination were being made, the model tunnel was shown to C. M. Holland, chief engineer of the New York-New Jersey Bridge and Tunnel Commission. Mr. Holland was very much interested in the model, and at his request it was put on display in the offices of the tunnel commission. While there it was seen by some of the New Jersey Senators, and at their request was shipped to Trenton, N. J., where it was exhibited for about two weeks in the rotunda of the State Capitol. During this time it was studied and commented upon very favorably by the entire legislature and by thousands of visitors.

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